MAY 3 1950

Sky and TELESCOPE

In This Issue:

Some Meteorology of Mars

The Present Phase of the Solar Cycle

American Astronomers Report

A Close-Approaching Asteroid

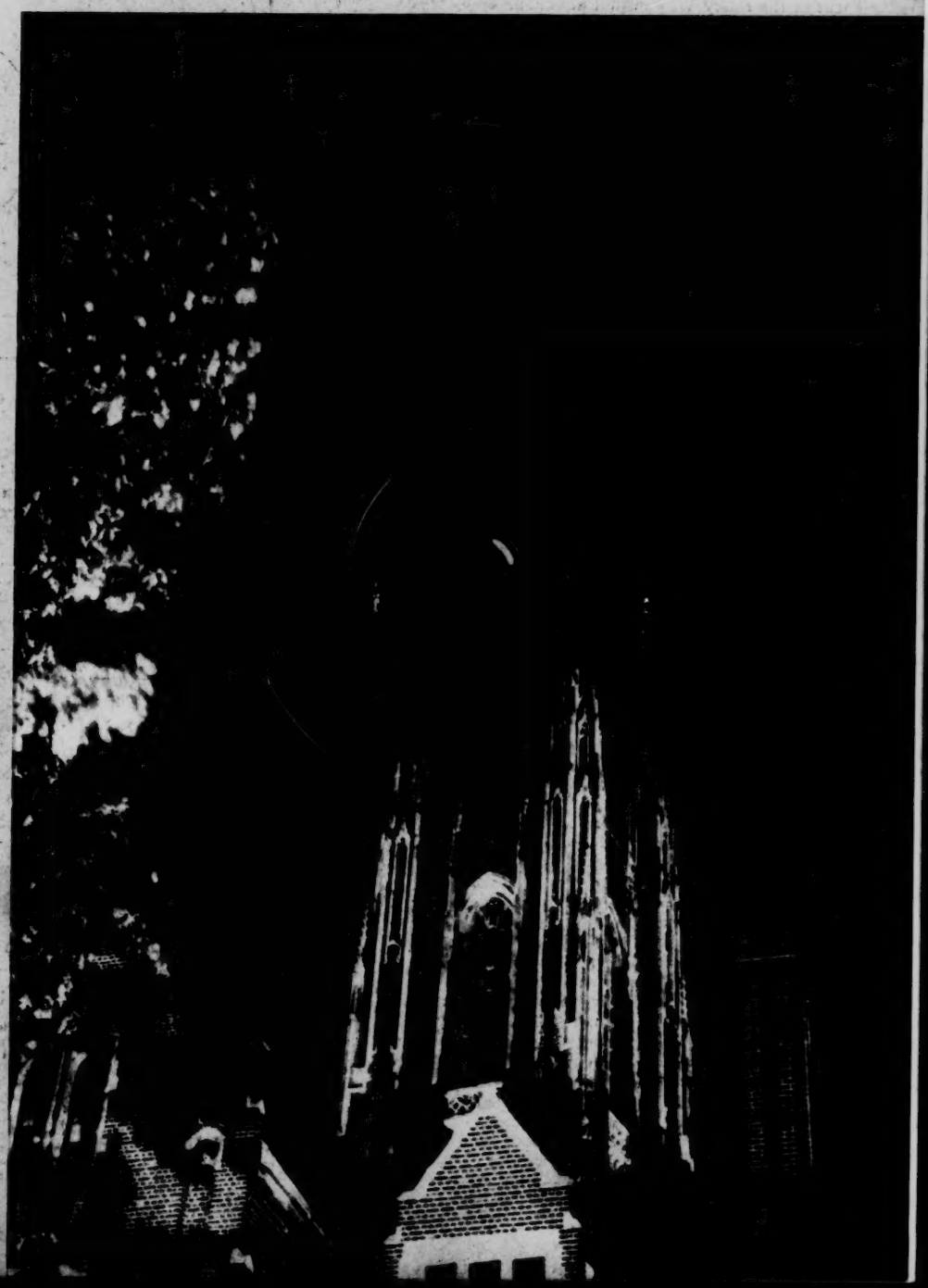
Variable Stars and Stellar Evolution — II

Northern and Southern Star Charts

★

Vol. IX, No. 7
MAY, 1950
Whole Number 103
25 cents

★



Star trails at Wellesley

In Focus

GLOBULAR CLUSTER NGC 2419, first observed by Sir William Herschel on December 31, 1788, is pictured on our back cover this month, from a negative taken with the 200-inch telescope, as one of the test objects following repolishing of a portion of the mirror last year.

"Intergalactic tramp" is the designation sometimes given to this cluster, because of its unusual location in that half of the sky that contains practically no other globular clusters. It is situated in Lynx, nearly opposite to the direction of the Milky Way galaxy center, and its distance is estimated as about 185,000 light-years from the sun, far beyond the probable extent of the Milky Way in that direction.

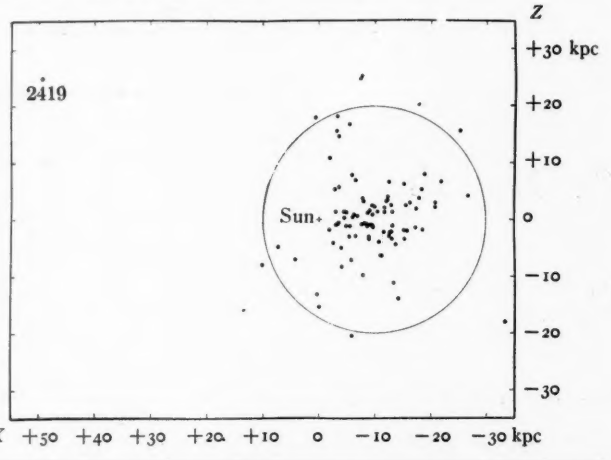
Many of the stars shown on the photograph are extremely faint and barely resolvable. The size of the smallest images is about 0.57 second of arc, or 0.0018 inch in diameter on the original negative. The picture was made under only moderate atmospheric conditions, and smaller 200-inch images can be obtained with better seeing. The picture shows, however, that the 200-inch mirror now performs as well as the best existing smaller mirrors, such as the 100-inch and the 60-inch at Mount Wilson.

In 1922, Dr. C. O. Lampland, of Lowell Observatory, pointed out the probability that NGC 2419 is a globular cluster, and from studies of Harvard and Lowell Observatory photographs Dr. Harlow Shapley estimated the distance from NGC 2419 to NGC 6517, another faint globular in the opposite part of the sky, as of the order of 350,000 light-years. At that time this was also considered the possible extent of the greatest dimension of the galaxy, but since then the known size of the system has "shrunk" and NGC 2419 appears to have little association with the other globulars, as the accompanying diagram shows.

The distribution of the globular clusters is known to be in a system more-or-less spheroidal in shape and centered on the center of the Milky Way galaxy. The sun is near the edge of this system; therefore most globulars are seen in one half of the sky.

The diagram is from the **Astrophysical Journal** for 1935, Vol. 82, No. 5, where Dr. Walter Baade, of Mount Wilson Observatory, published a detailed account of a special study of this globular cluster. On 100-inch photographs of the cluster were found 36 variable stars, 31 of which are short-period Cepheids. The fact that cluster-type Cepheids are all of about the same intrinsic luminosity made it possible to estimate how much their actual brightnesses are dimmed by the tremendous distance to the cluster. This dimming by distance, or **distance modulus,** was found by Baade to be nearly 19 magnitudes, taking into account interstellar absorption of some of the cluster's light.

From long-exposure photographs, the apparent diameter of the cluster was found to be about seven minutes of arc, corresponding to a linear diameter of about 117 parsecs. It is of the 11th magnitude photographic, of average spectral type **F5**. The cluster is of high luminosity and rich stellar content, containing at least 50,000 stars, the brightest of which are all red supergiants. Even in the dense central region the stars shown on the back-cover plate are about 50,000 astronomical units apart.



The spherical distribution of the globular clusters does not include NGC 2419. The plane of the paper is perpendicular to the principal plane of the galaxy. The distances (in kiloparsecs) have been corrected for the latitude effect. The sun is at the origin of the co-ordinates. Diagram by W. Baade from the "Astrophysical Journal."

Sky and TELESCOPE

Copyright, 1950, by
SKY PUBLISHING CORPORATION

CHARLES A. FEDERER, JR., *Editor*; HELEN S. FEDERER, *Managing Editor*

EDITORIAL ADVISORY BOARD: *Clement S. Brainin*, Amateur Astronomers Association, New York; *Edward A. Halbach*, Milwaukee Astronomical Society; *Donald H. Menzel*, Harvard College Observatory; *Paul W. Merrill*, Mount Wilson Observatory; *Charles H. Smiley*, Ladd Observatory; *Percy W. Witherell*, Bond Astronomical Club.

VOL. IX, NO. 7
WHOLE NUMBER 103

CONTENTS

MAY, 1950

COVER: Above the Carillon Tower on the Wellesley College campus, the north circumpolar stars trace concentric arcs around the pole. Wellesley is the site of the 1950 Astronomical League convention (see page 166). Photograph by the author from **Astronomy**, by John C. Duncan, with the permission of Harper and Brothers.

SOME METEOROLOGY OF MARS — Seymour L. Hess 155

THE PRESENT PHASE OF THE SOLAR CYCLE — Paul E. Roques 158

AMERICAN ASTRONOMERS REPORT 160

A CLOSE-APPROACHING ASTEROID 161

VARIABLE STARS AND STELLAR EVOLUTION — II — Otto Struve 162

Amateur Astronomers 166
Books and the Sky 168
Gleanings for ATM's 171
Here and There with Amateurs 177
In Focus 154
Letters 167
News Notes 165
Observer's Page 174
Planetarium Notes 159
Southern Stars 179
Stars for May 178
Terminology Talks 157

BACK COVER: The globular cluster NGC 2419, photographed late in 1949 with the 200-inch telescope. Its 1950 right ascension is $7^h\ 34^m.8$, declination $+39°\ 0'$; its galactic longitude is 148°, latitude +27°. On the edge of the picture is the very much overexposed image of a nearby star in the field, with halation caused by reflection from the back of the plate. Mount Wilson and Palomar Observatories photograph. (See In Focus.)

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $3.00 per year in the United States and possessions, and to members of the armed services; Canada and all countries in the Pan-American Postal Union, $3.50; all other foreign countries, $4.00. Make checks and money orders payable to Sky Publishing Corporation. Canadian and foreign remittances should be made in United States currency. Circulation manager: Betty G. Dodd.

All notices of change of address must be sent three weeks in advance and accompanied by old and new addresses, or we cannot make the proper change. When sending your renewal order, or writing in regard to your subscription, your current mailing address must be given. For most efficient handling of your subscription, please return our bill form with your renewal payment.

Editorial and advertising offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited manuscripts unless return postage is provided by the author.

Some Meteorology of Mars

The Distribution of Mars' Temperature and Its Atmospheric Circulation

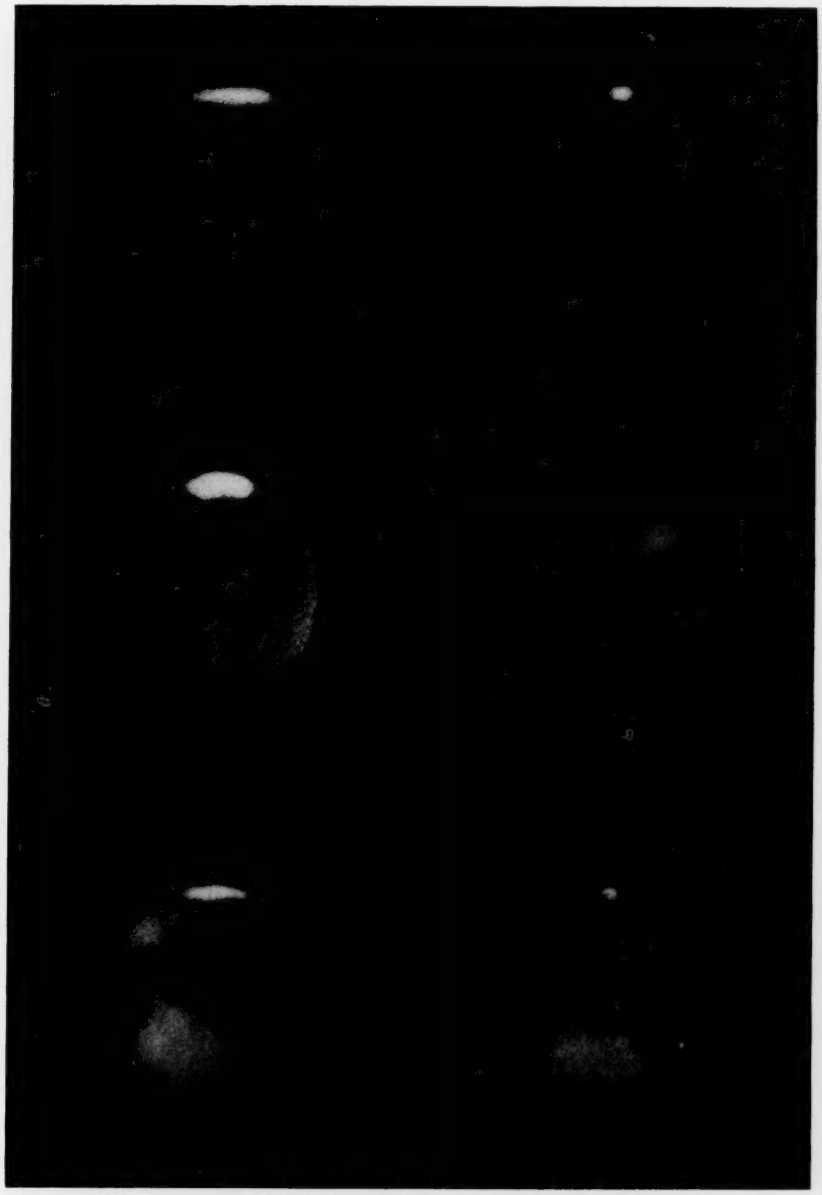
By Seymour L. Hess, *Lowell Observatory*

THE TEMPERATURES of the planets are generally measured by observing the spectral distribution of the radiation coming to us. One method is to measure, with a radiometer at the focus of a reflecting telescope, the total energy of the radiation arriving from the planet (the sum of reflected short-wave solar energy and long-wave planetary radiation). Then, by interposing a water cell, which does not transmit long-wave radiation, the amount of short-wave energy alone is measured. The difference between the two represents the energy emitted by the planet itself and can be used, via the fourth-power law of radiation, to compute the temperature of the radiating surface. Measurements of this sort have been made by Coblentz and Lampland, and by Pettit and Nicholson.

For meteorological purposes, these measurements are of particular interest because the thermocouple which receives the radiant energy can be made so small as to cover less than 1/10 the diameter of the disk of Mars. That is, it is possible to measure the energy coming from a region as small as 200 miles in radius. This is as close to determining the temperature at a point as one could possibly hope for under the circumstances. Thus the attractive possibility exists of drawing a temperature map of Mars, provided the observations are sufficiently accurate and numerous.

Before presenting the result of such an attempt, it is desirable to indicate some of the difficulties and sources of error in these measurements. One of the most important uncertainties in the technique of obtaining temperature by measuring the radiation emitted by the surface of Mars comes from the fact that this radiation must pass through both the Martian and the terrestrial atmospheres. As a result, the beam is selectively diminished by absorption. Since the essence of the method lies in a comparison of the energy of the long-wave portion of the spectrum with that for the entire spectrum, it can be seen that the selective nature of this absorption is an important matter. The part of this effect which is due to the Martian atmosphere is probably unimportant because the small amounts of water vapor and carbon dioxide present absorb relatively little radiation. The part due to our own air is important, and the radiation so lost is restored in the calculations by making use of the known transmission of our atmosphere. This transmission depends upon the total water in the path of the radiation. In the measurements discussed here, this was estimated from surface psychrometer readings. More appropriate techniques are now available.

Two factors which enter into the computation of the temperature are the local albedo and the surface emissivity. The first of these enters because it determines the part of the incident solar



These photographs in yellow light all show about the same face of Mars. At left are three views during southern hemisphere springtime (oppositions of 1907, 1924, 1939), and on the right are three views in southern hemisphere summer (oppositions of 1909, 1926, 1941). In each case the transition from spring to summer was associated with the development of a broad dark band (the Pandorum Fretum) in the Deucalion region poleward of the Sabaeus Sinus. In effect, the Sabaeus Sinus seems to have doubled. The radiometer registered a relatively high temperature when set on the Pandorum Fretum. Lowell Observatory photographs by E. C. Slipher.

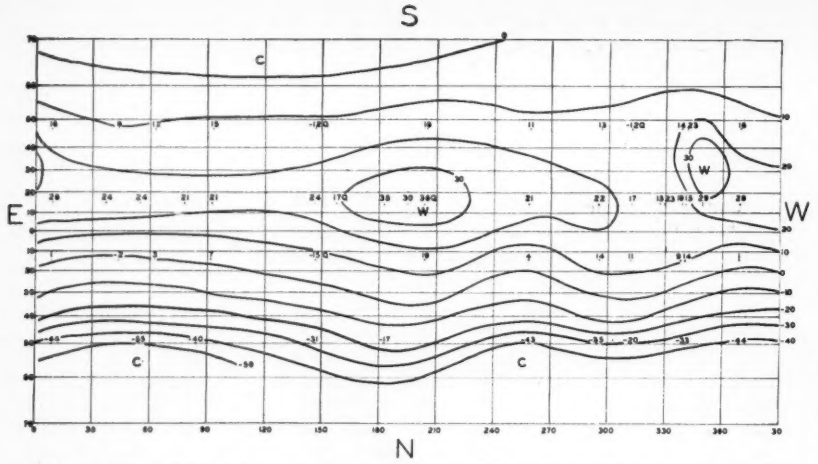


Fig. 1. The distribution of temperature (centigrade) on Mars in northern hemisphere winter. This is the telescopic view with south at the top. To obtain the usual meteorological view, merely invert the page. The observations marked Q are questionable, either through being interpolated values or because of the presence of clouds.

energy which is directly reflected. A different value should be used for each portion of Mars' surface, hence the designation "local." The local albedo is difficult to estimate or measure, and so represents a source of uncertainty. The emissivity of the surface is unknown and is taken to be unity. Since this is an upper limit on the true emissivity, all temperatures so calculated must be somewhat too low. Temperature differences between various regions should be much less affected, however. Fortunately, it is the fourth root of both the local albedo and the emissivity which is used in calculating the temperature, so that errors due to these approximate factors are markedly minimized.

One last remark should be made about interpretation of the results. These are not the temperatures that we customarily measure in meteorology, namely the temperature of the air some five or more feet above the ground. They are largely estimates of the temperature of the surface itself. On this account they tend to be higher than the values one would obtain by the normal meteorological procedures.

The most suitable set of published data for our purpose is that obtained by Coblentz and Lampland in 1926. Measurements were made with tiny receivers at the limbs of the planet and at various latitudes in the center of the disk for about a month. In order to avoid the diurnal variation of temperature from one limb of the planet to the other, we shall use only the values along the central meridian. These are plotted in Fig. 1 along with the isotherms (lines of equal temperature).

In view of the difficulties discussed above, the specific values are not to be relied upon to within some five or 10 degrees centigrade. If one grants this amount of leeway in drawing the isotherms, the temperature distribution becomes remarkable for its consistency and smoothness. There is not a single observation plotted in Fig. 1 which cannot be accounted for in a quite reasonable fashion. This constitutes a clear indication of the internal consistency of these exceedingly difficult measurements.

From the meteorological point of view, the salient features are a belt of high temperature at about latitude 20° in the summer hemisphere, markedly lower temperatures and larger gradients in the winter hemisphere, and an anomalously warm region around latitude 30° S., longitude 350°. The first two features are in qualitative agreement with the situation on Earth, while the last feature is indicated by more than one datum and, as will be seen later, coincides in location with an anomalous wind observation.

Given such temperature distribution, one could almost delineate the broader aspects of the general atmospheric circulation. If one could obtain in addition a few, representative, well-distributed wind directions, the task would become easier and the result more objective. Fortunately this is possible, and some 18 wind directions obtained from the drift of clouds on the terminator and limb have been calculated. All these drifts were observed during winter of the northern hemisphere, but they come from different oppositions, those of 1894, 1896, and 1924. We immediately realize the danger of combining occasional winds from three widely separated years with the temperature field for still a fourth year. However, we shall make the attempt, bearing in mind the heterogeneous nature of the data.

The result of this reconstruction is given as a streamline map in Fig. 2. This map has been drawn so as to be consistent with the temperature field, with as many of the observed winds as possible, and with general meteorological principles. While these do not suffice to define the flow pattern uniquely, the amount of pure imagination required was quite small. In one sense this is a mean map, since it is based upon a smoothed temperature distribution. On the other hand, whenever individual winds could best be fitted by drawing ephemeral structures, like frontal systems, this was done. It is difficult to specify the atmospheric level described by this map. The temperature field upon which it is based is for the surface, but the winds are derived from the motions of clouds at some considerable elevation. Fig. 2 is probably most closely analogous to the usual terrestrial sea-level weather map.

The most striking aspect of Fig. 2 is its resemblance to terrestrial weather maps. This is by no means due solely to a tendency on the analyst's part to force the pattern into a familiar shape.

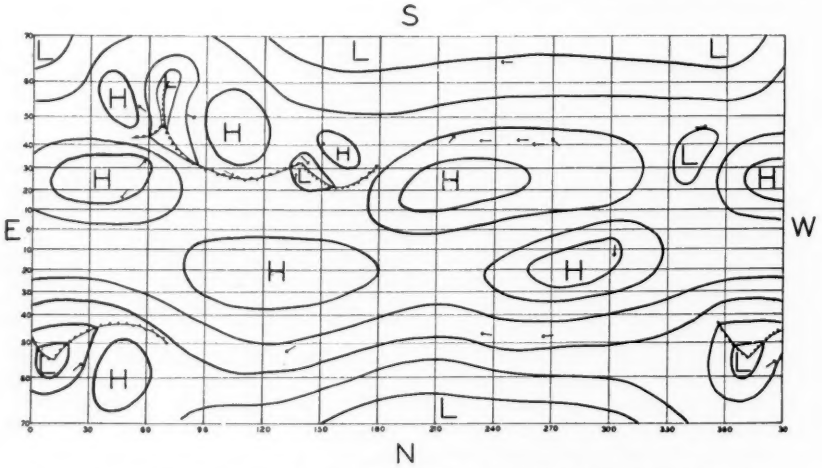


Fig. 2. A schematic streamline map for Mars in northern hemisphere winter. South is at the top. To obtain the usual meteorological view, merely invert the page. The arrows represent observed cloud drift directions.

An examination of the winds will show that the broader aspects of this map could not be altered very much by an independent analysis. The existence of a more-or-less broad belt of westerly winds in both hemispheres is clearly indicated, and there are observations to support the drawing of a pair of subtropical belts of high pressure circulation which are broken up into individual cells. The pairs of winds which form the basis of the two cyclonic storms indicated in the southern hemisphere are in one case synchronous and in the other case were observed on successive nights. Thus there is no way of avoiding an analysis involving sharp cyclonic shears, without ignoring the data. Nevertheless, it must be admitted that the frontal systems drawn represent one of the more imaginative aspects of Fig. 2.

The cyclonic circulation at latitude 35° S., longitude 345°, which is indicated by a cloud-drift observation, is of particular interest. The observed wind direction is in a latitude where one would expect a westerly rather than an easterly direction; therefore the possibility must be considered that it is either unrepresentative or erroneous. But this is the region in which the temperature distribution indicates an abnormally warm spot. It seems probable that we have here an example of a heat low. A "heat low" is a cyclonic circulation induced around a region of higher temperature; as an example, the southwestern United States has such a system during the summer. This is all the more remarkable because the two pieces of evidence are a cloud drift observed in 1894 and a temperature field determined in 1926. This persistence points to a local peculiarity of either topography or soil character that is conducive to high summer temperatures and the formation of a heat low. And, indeed, at this Martian season the region in question is normally quite dark, which would tend to produce high temperatures. At other seasons the dark coloration disappears almost completely. It would be interesting to obtain similar temperature measurements at other Martian seasons to determine whether this warm spot vanishes with the seasonal increase in albedo.

So far our discussion has emphasized the resemblances between the atmospheric circulations on Mars and Earth, these being due to a close correspondence in the rates of rotation and inclination of the axes, among other things. Several factors which should contribute to differences in circulation are the Martian absence of oceans and sharp mountain ranges, lesser water vapor content, and the longer year on Mars. The greater uniformity of the Martian surface should lead to a more pronounced regularity in weather. The almost complete absence of water vapor on Mars means that insolation and outgoing radiation are quite regular and are not subject to the erratic interference found on Earth. As atmospheric motions depend ultimately upon these radiation currents, this very likely means a greater regularity in the circulation pattern. These two factors are probably responsible for the relative ease with which the heterogeneous data of Fig. 2 were combined into a harmonious picture.

The fact that the Martian year is almost twice ours means that the temperature contrast between the winter and summer hemispheres ought to be larger on Mars. Here on Earth one can deal with the circulation qualitatively by assuming it to be driven by the temperature difference between equator and poles. While this would not be completely invalid on Mars, it would seem that the temperature contrast between the hemispheres should also be an important factor. That is to say, the long seasons on Mars would seem to promote, as a major feature of the circulation, an exchange of air between hemispheres.

TERMINOLOGY TALKS.

J. Hugh Pruett

Fractional and Negative Magnitudes

With the aid of modern light-measuring instruments, stellar magnitudes can be measured quite accurately to two decimal places. Aldebaran, the orange star in the Hyades, is almost a standard 1st-magnitude star, at 1.06. But there are other stars which are far brighter that are generally classed in this same magnitude group. When the ratio of 2.512 is applied, the numbers representing the brightnesses of some of these stars come out less than one: Arcturus, 0.24; Capella, 0.21; and Vega, 0.14. When we get to Alpha Centauri, 0.06, we seem to be about down to "nothing."

However, if we do not fear our algebra, we can step serenely through zero into the realm of negative numbers. Thus 0.00 indicates a brightness 2.512 times greater than 1.00; likewise −1.00 is 2.512 times brighter than 0.00, and so forth. Canopus rates −0.86; Sirius, −1.58; Venus at its best, −4.4; an average full moon, −12.6; and Old Sol, −26.7.

Photographic Magnitude

To this point, our discussion of the apparent magnitudes of stars has been of brightness determined by visual (eye) methods. By employing photography, we can avoid the errors caused by the personal differences of various observers, and magnitudes estimated on photographic plates can be verified at any time.

Such magnitudes, called *photographic,* may be measured on the basis of the size or density of a star's image, or both. The size increases with exposure time, and is greater for brighter stars — therefore it is a directly measurable quantity. Great care must be taken, however, to have uniformity of exposure, emulsion sensitivity, development, and the like, in order to produce reliable photographic magnitudes.

Color Index

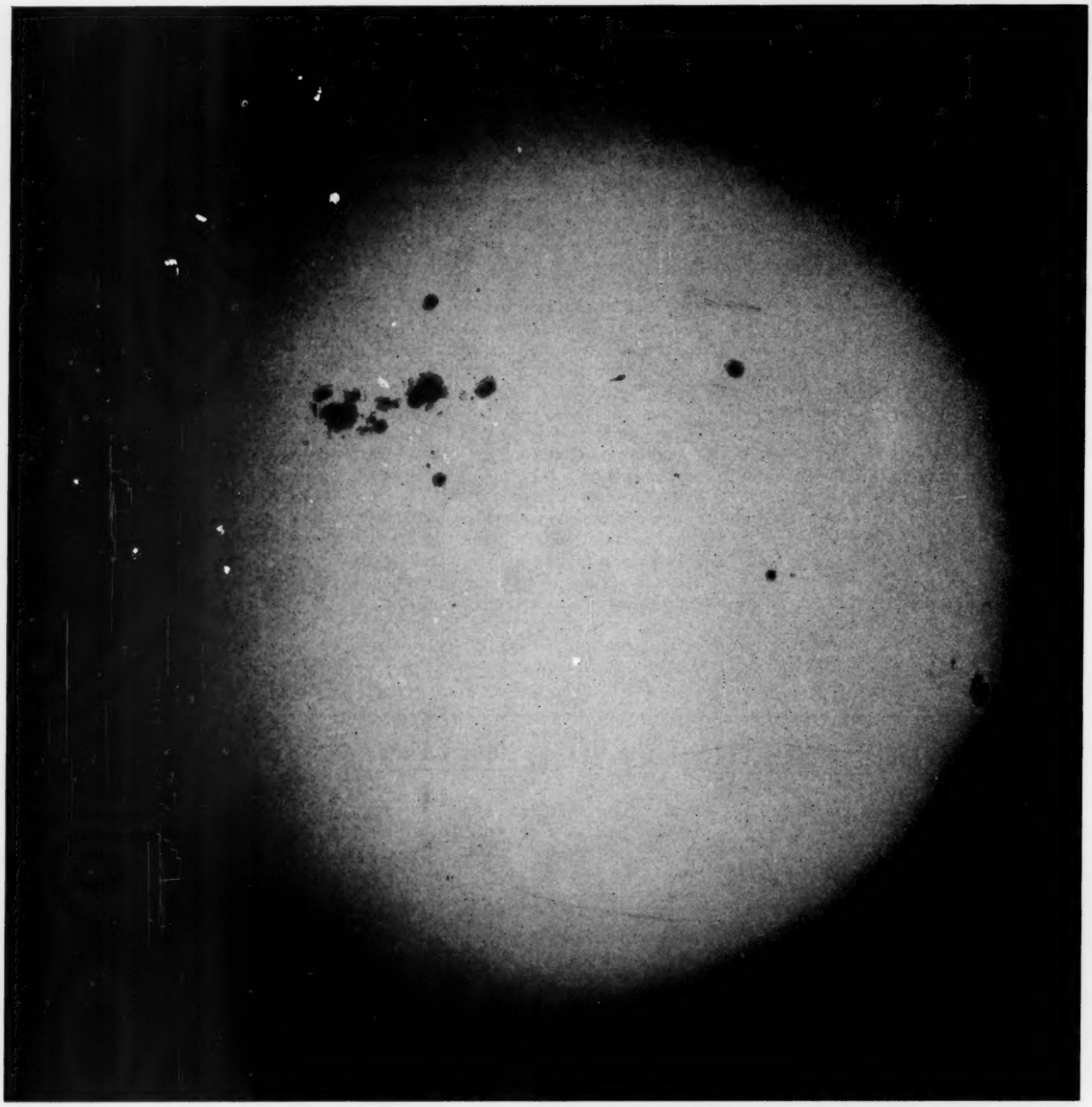
Inasmuch as the photographic plates usually employed are far more sensitive to blue and violet light and less sensitive to the red than is the human eye (which sees best the yellow and green), the magnitudes obtained by photography differ considerably in many cases from visual magnitudes. A red star which seems bright to the eye may photograph relatively dim; an example is the faintness of Betelgeuse in the ordinary photographs of the constellation Orion.

The two types of magnitude may be compared by what is known as *color index.* This is defined as the photographic magnitude minus the visual magnitude, easily remembered from P — V, in which the letters come in the order they appear in the alphabet. The white stars such as Vega and Sirius are of about the same magnitude on the two scales, so their color index is near 0.0. The actual agreement is for stars of magnitudes 5.5 to 6.5 and of spectral class *A*0, by definition.

For the very bluest stars, this index seldom runs to more than −0.3; for the red ones it is as high as +2.0, or greater. Thus, a red star that would measure magnitude +13.0 by the visual scale might be two magnitudes dimmer photographically, or only +15.0. The star at the top of the Southern Cross, Gamma Crucis, has a visual magnitude of 1.97, a photographic magnitude of 3.57, and a color index of +1.6. This accounts for its faintness on ordinary photographs of Crux.

Photovisual Magnitude

Since the early days of celestial photography, light-sensitive emulsions have been developed for all regions of the visual spectrum, and for the infrared as well. Consequently, astronomers can now choose the particular range of wave lengths most suitable to their requirements. With emulsions having peak sensitivity in the green and yellow, and with filters eliminating much of the blue and violet in starlight, photographic magnitudes may be obtained which are of nearly the same values as those determined visually for the same stars. Magnitudes obtained in this way are known as *photovisual* — they are a special kind of photographic magnitude.



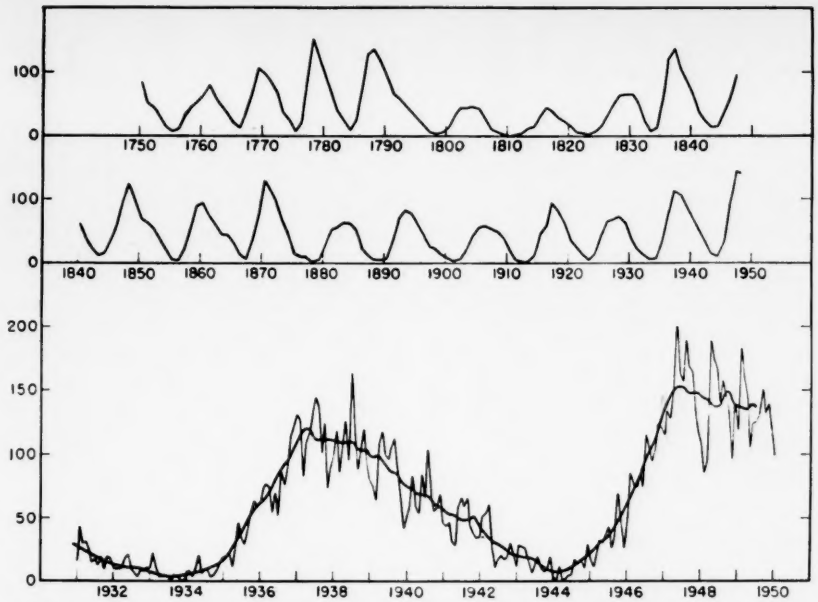
Although the maximum of sunspot activity is believed to be past, the sun shows frequent outbursts of spots. This picture of the sun on February 18, 1950, fits into the series from the U. S. Naval Observatory published on page 139 last month. Mount Wilson Observatory photograph.

The Present Phase of the Solar Cycle

By Paul E. Roques, *Mount Wilson and Palomar Observatories*

THE TIME of the last sunspot maximum as determined at Zurich was 1947.5. Although this was almost three years ago, sunspot activity has remained at a relatively high level. It has decreased only 10 per cent since maximum, and is still nearly 14 per cent above the maximum of 1937. As can be seen in the diagram, maxima have been alternately high and low since 1850. If this alternation had continued, the maximum of 1947 would have been lower than the high one of 1937. The maximum of 1947, however, did not follow this rule, but proved to be the highest ($N=152$) since 1778 ($N=154$). It was approached only by the maxima of 1837 ($N=138$) and 1870 ($N=139$).

The average latitude of spot groups decreases steadily from approximately 25° at the beginning of a new cycle to about 5° at the end of the cycle. At maximum the average latitude is about 15°. The latitude of sunspots during the present cycle has decreased at the expected rate, being 17°.3 in 1947, 14°.3 in 1948, and 13°.4 in 1949. The relatively high average latitude at maximum was due to the early occurrence of maximum in the cycle.

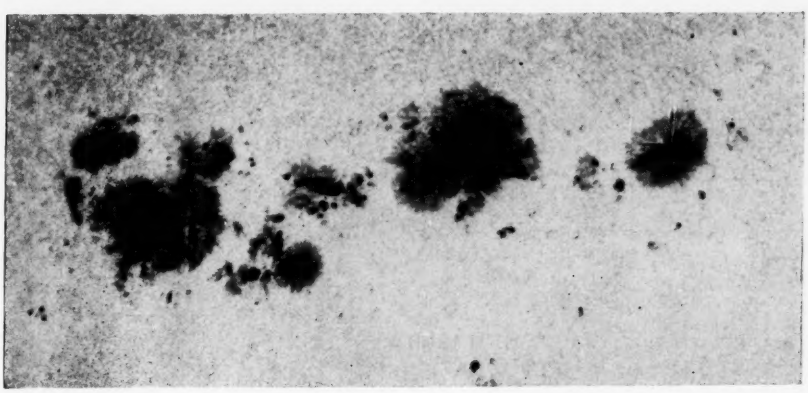


The sunspot cycle for nearly two centuries, and a more detailed graph of the current cycles. Zurich relative sunspot numbers are plotted against time. The relative spot numbers are computed from the formula $N = k(n+10g)$, where N is the Wolf number, n is the number of individual sunspot umbrae, g the number of groups, and k a constant determined from the observing conditions. Mount Wilson Observatory diagram.

Sunspot maximum is the time when the relative sunspot numbers, smoothed by a 12-month running average, reach their highest value. If the American sunspot numbers are smoothed this way, the time of maximum becomes 1948.8. This apparent discrepancy between the Zurich and American observers is probably due to the difference in the method of reduction of the observations. Since the typical maximum has numerous fluctuations and is quite broad, there is always some uncertainty in the determination of the time of greatest activity. If the two hemispheres are considered separately, a difference of two years between northern maximum and southern maximum is found in the present cycle, the southern maximum having occurred in 1947, the northern in 1949.

Several active sunspot groups were observed in 1950, one of which is shown in the accompanying illustration. This group (Mt. Wilson No. 10233) was of mixed polarities and very active. On February 20th, when the group was near the central meridian, an intense magnetic storm occurred, accompanied by radio fadeouts, as described on page 139 last month. Undoubtedly several more groups of this type can be expected before sunspot minimum. However, as minimum is approached, the number of spots will decrease to such an extent that large groups will be rare.

The time of the next sunspot minimum can be estimated only from the average length of the cycle (11.1 years), and the average time from maximum to minimum. With the Zurich value for the latest maximum, the minimum will probably be in 1955.



A close-up view of the sunspot group in the picture on the opposite page, photographed at Mount Wilson Observatory on the 18th of February this year.

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evenings, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BOSTON: *Little Planetarium.* Boston Museum of Science, Science Park, Boston 15, Mass. Richmond 2-1410.

SCHEDULE: Tuesday thru Friday at 3:30 p.m.; Saturday, 2:00 and 3:30 p.m.; Sunday, 3 and 4 p.m. Spitz projector. In charge, Charles A. Federer, Jr.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Director, Roy K. Marshall.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P.O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday and Thursday at 8:30 p.m. Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Curator, Gordon A. Atwater.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings as 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Sunday, 4:15 p.m. Special showings on request. Admission free. Spitz projector. Director, Robert E. Cox.

American Astronomers Report

Here are highlights of some papers presented at the 82nd meeting of the American Astronomical Society at Tucson, Ariz., in December. Complete abstracts will appear in the Astronomical Journal.

CQ Cephei

WOLF-RAYET stars are characterized by the wide, bright lines in their spectra, but the origin of these lines is not entirely understood. This emission appears to arise in an envelope of luminous gas that surrounds a central star or nucleus. In an attempt to ascertain the relative size of such an envelope, Dr. W. A. Hiltner, of Yerkes and McDonald Observatories, has made photoelectric measurements of the intensity of the emission line of ionized helium at 4686 angstroms in the spectrum of CQ Cephei, an eclipsing binary with a Wolf-Rayet component.

If the emitting atoms are in an envelope large relative to the Wolf-Rayet nucleus, there should be little change in the intensity of the emission as the star is eclipsed by its companion. If the emission originates in a compact envelope, an eclipse of the emission should be observed during the stellar eclipse.

A photomultiplier tube was attached to the Cassegrain spectrograph of the 82-inch McDonald reflector. The emission line of He II 4686 plus 70 angstroms of continuous spectrum was compared to 70 angstroms of continuum to the red of the emission line. The intensity of the emission line corresponded to a star of magnitude 14.5. A light curve of moderate precision was obtained. It was found that the emission line undergoes a continuous variation in intensity, but with two maxima and two minima in the period of the binary, which is 1.64 days. The total amplitude of the light variations is 0.4 magnitude.

When either star is eclipsed the emission is strongest; it is slightly brighter when the Wolf-Rayet component is eclipsed. At either elongation the emission is weakest, and faintest when the Wolf-Rayet component is receding from the observer. The cause of this strange behavior of the emission is not known, but Dr. Hiltner believes that further investigations of CQ Cephei and of other such Wolf-Rayet binaries may lead to a better understanding of Wolf-Rayet stars in general.

Dwarf-Star Symposium

SIX astronomers took part in a symposium on some problems of dwarf stars. The president of the American Astronomical Society, Dr. A. H. Joy, of Mount Wilson Observatory, discussed the spectra of late-type dwarf stars. The near neighbors of the sun are so small and faint that they can be observed in detail only with the largest telescopes. Dr. Joy pointed out that a great majority of the faintest dwarfs have low temperatures (3,000° - 3,500° C.) and *M*-type spectra showing the bands of titanium oxide in considerable strength.

From Mount Wilson spectra W. S. Adams found that the intensities of certain lines of strontium and calcium varied with the absolute luminosity of the stars. This powerful method of determining absolute magnitude is entirely independent of the distance of the star. Also, emission lines of hydrogen and calcium were found to be of frequent occurrence among the *M*-type dwarfs — in types later than *M*4 emission was found in 80 per cent of the stars observed, its origin and significance as yet inadequately explained.

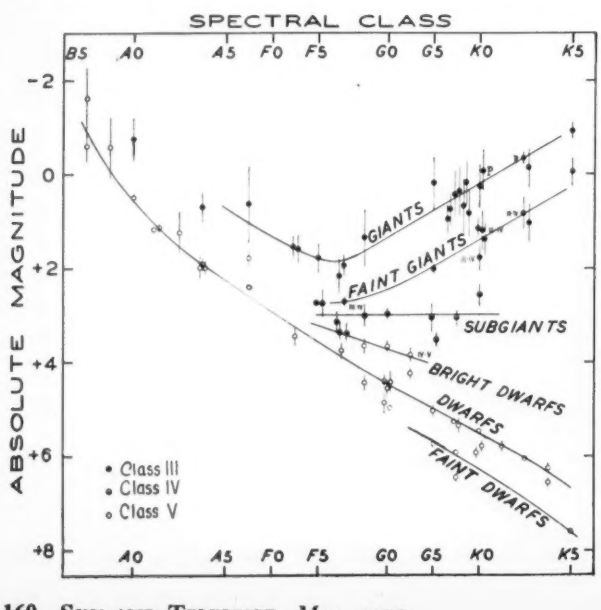
Many of the stars involved in the dark clouds of the Taurus region of the Milky Way have spectra similar to those of the red dwarfs. In such cases, the contact of the dust of the cloud with the atmosphere of the moving star may explain the bright lines in the spectrum. In both the red dwarfs and the Taurus emission stars sudden outbursts of light have been observed, reaching their maxima in a few minutes of time and accompanied by spectacular changes in their spectra, all unexplained at present.

The second symposium paper was by Dr. R. E. Wilson, also of Mount Wilson Observatory, concerning the dwarf stars in the Hyades. This famous cluster in Taurus has long been known as one of the nearest of the moving clusters; therefore its distance has been determined in several ways, including that from the apparently converging proper motions of its individual stars.

Dr. Wilson pointed out that along the dwarf sequence in clusters there is a close correlation between apparent magnitude and spectral type, and he sought to verify this by studying the luminosities of Hyades stars with spectral types between *A*4 and *K*6. He finds that spectral type and magnitude have a close relationship, with a dispersion about the mean curve of 0.26 absolute magnitude. This dispersion may arise from various sources, such as a few poorly determined magnitudes, small errors in the estimation of spectral types, the presence of a few binary systems or of subdwarfs, and the dispersion in the depth of the cluster itself. He concluded by saying:

"It would appear that the absolute magnitude of a normal dwarf of type *A*5-*K*5 may be taken with confidence from a Hertzsprung-Russell diagram. This thus becomes an effective tool for the estimation of stellar distances."

Next, Dr. H. F. Weaver, of Lick Observatory, discussed the probable existence of several separate sequences of stars in the Hertzsprung-Russell diagram. On the basis of analyses of such standards as the stars in the Morgan, Keenan, Kellman *Atlas of Spectral Classification,* which includes nearly 60 per cent of all stars nearer than 10 parsecs and north of −20° declination, Dr. Weaver has constructed H-R diagrams like that reproduced here. As Kuiper has pointed out, the H-R diagram representative of our region of the galaxy should be compared in form to a reversed "y" instead of to a reversed "7."



A spectrum-luminosity diagram derived by H. F. Weaver from the stars in the "Atlas of Spectral Classification," by Morgan, Keenan, and Kellman. Probable errors in the stars' absolute magnitudes, computed from probable errors in the apparent magnitudes and trigonometric parallaxes, are indicated by vertical lines of appropriate lengths. Luminosity class is shown by the symbol for each star.

The *Atlas* standard stars give evidence for a sequence of intermediate giants, called *faint giants* by Dr. Weaver, lying more than a magnitude below the ordinary giants. The *Atlas* standards, the high-velocity and low-velocity stars of large parallax (nearby stars), the galactic clusters, and the visual double stars all suggest that what is ordinarily termed the main sequence is, in fact, composed of three closely adjacent sequences, which are called *bright dwarf, dwarf,* and *faint dwarf,* for purposes of discussion. There is a progressive terminating value for the giants, faint giants, subgiants (a sequence hitherto recognized), and the bright dwarfs, the last including no stars later than the middle of spectral class *G*.

The ordinary high-velocity and the low-velocity stars both populate the bright dwarf, dwarf, and faint dwarf sequences, and in roughly the same proportions; hence their H-R diagrams are the same. This latter fact was first suggested by Oort more than 20 years ago.

These three lower classes appear to exhibit spectral differences which Dr. Weaver pointed out provisionally for some particular groups.

Not included in the diagram here are the subdwarfs, a sequence established earlier, which seem to be at most only one or two per cent as numerous as the dwarfs and faint dwarfs. The subdwarfs are less luminous than the faint dwarfs, and appear, as a class, to be high-velocity stars, with marked spectral peculiarities.

Dr. Gerald E. Kron, of Lick Observatory, described detailed observations made with a photoelectric photometer of four late-type dwarf stars, of which he called the "key star" YY Geminorum, the third component of the multiple star Castor, and a famous eclipsing variable. A secondary variation has been noted, not associated with the eclipsing process but plainly connected with orbital revolution. Dr. Kron suspects nonuniform or "patchy" surface illumination of the two stars.

The second star is Ross 248, an emission-line subdwarf of very low luminosity, which was observed in this program for over 100 days. Although it is a single star, it has a light variation of 0.06 magnitude in a period of 115 days. Possibly the variation is caused by axial rotation of the star combined with a patchy or spotted surface. If such proves correct, this will be the first time the rotation of a slowly rotating star other than the sun has been determined.

The third star is BD +20° 2465, a late-type single dwarf showing emission lines. The first night the star was placed under observation, it underwent an exciting, spectacular outburst of light of more than 0.4 magnitude in only six minutes. Dr. Kron believes a violent physical process must have taken place over an extremely small area of the star (see *Sky and Telescope,* January, 1950, page 54).

Another late-type dwarf, CC 1250a, was included by Dr. Kron in his program as a kind of control to show that his methods can result in indicating a constant light source where one exists. Probably this star is being observed from above its pole, so that axial rotation does not cause light variation.

The four stars discussed are all small, cool objects of low luminosity. All are smaller and cooler than the sun, and all are nearby stars with easily measurable distances.

Of a nature probably very different from the ordinary dwarf stars of the late spectral types are the white dwarfs, stars that have relatively high surface temperatures, as indicated by their whiteness, but low luminosities. Therefore,

(Continued on page 164)

A Close-Approaching Asteroid

THE ASTEROID found in February at the Lick Observatory and noted on page 137 of the April issue has an unusual orbit that brings it relatively close to the orbit of the earth. The finding of a pre-discovery trail of the asteroid on a long-exposure photograph, taken February 17.3 at Lick, furnished data needed by Dr. Leland E. Cunningham, University of California, to calculate a fairly definite orbit. Even so, the period of the asteroid's revolution around the sun, given as 2.11 years, is still uncertain by a few months.

Perihelion passage (nearest the sun) was expected on April 17th, at a distance of 0.84 astronomical unit or 78 million miles. On March 13th, the earth and the asteroid were only 5,400,000 miles apart, and this distance could be even less on another occasion were the asteroid and the earth to reach the appropriate points at the right time. For the asteroid's orbit crosses above the earth's, as indicated in the accompanying diagram. This explains the asteroid's unusual position in the sky, near the Big Dipper, at the time of its discovery. The inclination of the orbit is only about 12 degrees; it was above the plane of the ecliptic in February and early March, but at perihelion was below it; not until about October will it reach its ascending node.

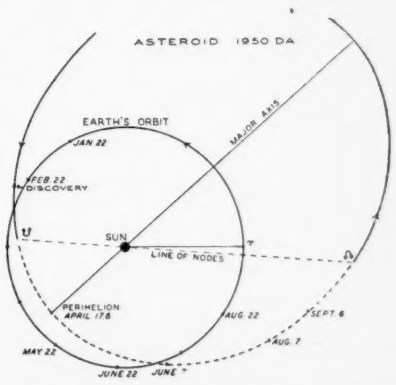
For the next several months the position of the asteroid in Cetus and Aquarius will change very little, and it will be favorably placed for observation with large telescopes (magnitude 18). As the asteroid's distance from the sun increases, its speed will decrease and the earth will actually catch up to it a bit in July. This will enable continued observations and probably a more accurate determination of the orbit of this asteroid than hitherto possible for such close-approaching bodies.

In his book, **Between the Planets,** Dr. F. G. Watson points out that a small number of asteroids are known that have rather long, oval orbits and low inclinations to the ecliptic. In 1912 Albert came close to the earth, but has not been seen since. In 1932 Apollo and Amor both came close, but Apollo's orbit is poorly determined, and only Amor has a reliable orbit. It was seen again in 1940, and its minimum distance from the earth seems to be about 10 million miles, about twice that of the new asteroid (1950 DA). On October 30, 1937, Hermes went by scarcely three times the moon's distance from us, but it crossed the sky so fast that few observations were possible and its orbit is uncertain. Watson says, "There is little hope that they [Apollo and Hermes] will be observed again except by accident when they happen to pass near the earth during some future dash around the sun."

The eccentricity of the orbit of 1950 DA is close to 50 per cent, which makes its aphelion distance nearly three times perihelion, or about 2½ astronomical units, well beyond the orbit of Mars.

On about June 1st, the asteroid and the earth will be the same distance from the sun, but the asteroid will be more than half as far (55 million miles) ahead of us. It will be much fainter than the 14th magnitude at which it was first found. The change in brightness to 17th magnitude will result partly from the increased distance of the asteroid from us and partly because of the angle at which it reflects sunlight. Its phase in June will resemble that of a quarter moon, except that no disk will be seen, if, indeed, it is disk-shaped. But the phase will increase until in September the full sunlit side of the asteroid will face us, but then its distance from the sun will be 1.7 astronomical units, and it will be 60 million miles from the earth. The predicted magnitude then is 17.6. The size of the asteroid is very uncertain, but is probably on the order of a mile.

Because of its faintness, there is little chance that 1950 DA will replace Eros as the near-approaching object by which the scale of the solar system is measured. Eros' minimum distance from the earth is about 14 million miles; Venus', about 26 million; Mars', about 35 million.



The orbit of asteroid 1950 DA, shown solid where it is above (north of) the plane of the earth's orbit, dashed where it is below. The orbit is inclined about 12 degrees to the ecliptic; its exact size is uncertain.

Variable Stars and Stellar Evolution - II

By Otto Struve, *Yerkes and McDonald Observatories*

CERTAIN ANOMALIES among the Cepheid variable stars were discussed last month. It is particularly striking that both Population I (young, nearby) stars as well as Population II (old) stars are to be found among Cepheids, the former represented by the ordinary Cepheids and the latter by the W Virginis stars, and that these have, however, much in common.

In recent years the Russian astrophysicist B. V. Kukarkin has made a concerted attack upon this kind of problem. A recent book by him under the title, "The Structure and Evolution of Stellar Systems Based upon the Study of Variable Stars," is entirely devoted to this aspect of the physical variable stars. The foundations of his work rest in part upon the results obtained during the past 50 years at Harvard Observatory.

He excludes the eclipsing binaries and those somewhat hypothetical stars that may change in light because of variable obscuration produced by clouds of interstellar dust. Among the physical variables, those of the *great sequence* present the greatest interest because they are better known and are more numerous than the other groups of variables. All the variables of the great sequence obey two statistical relations: the period-luminosity relation and the period-spectrum relation. Both have been known for a long time, but Kukarkin has rediscussed the latest observational data. Fig. 1a shows his period-luminosity relation. The ordinate is the absolute photographic magnitude of the stars (which measures the intrinsic luminosity) and the abscissa is the logarithm of the period. For the short-period stars and for those of intermediate period, the median brightnesses of their light curves are plotted. For the long-period stars the brightnesses at maximum light are given. The intermediate group of classical or long-period Cepheid variables represents a fairly homogeneous system ranging in period from slightly more than one day to slightly less than 100 days. This sequence is not immediately joined by the cluster-type (RR Lyrae) variables on the one side and by the Mira Ceti variables on the other side. The discontinuity is especially pronounced between the long-period Cepheids and the Mira Ceti variables at about 100 days. Since there are also pronounced differences in the forms of the light curves, the velocity curves, and the spectral characteristics

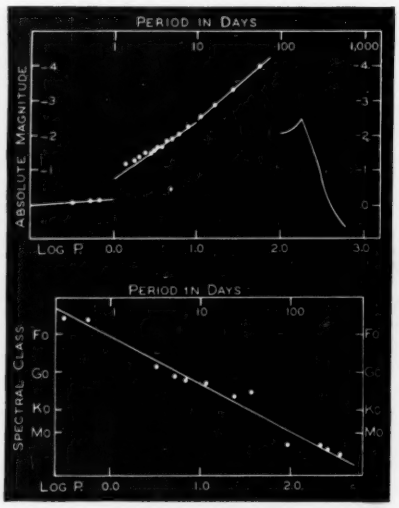


Fig. 1a (top). The period-luminosity relation of three groups of variable stars. The cluster-type variables are on the left; the classical Cepheids form the middle section; the Mira Ceti stars are on the right.

Fig. 1b (bottom). The period-spectrum relation for the same kinds of variables.

of these three groups, we have for many years been treating them as three distinct systems of variable stars which are related to one another, but which nevertheless present differences.

No such discontinuity is apparent in the period-spectrum relation in Fig. 1b. Here the cluster-type variables have the earliest spectral types and consequently the highest photospheric temperatures; the Cepheid variables have intermediate spectral types and also intermediate temperatures; and the long-period variables have the latest spectral types and the lowest temperatures.

It should be noted that the points plotted in these diagrams are the mean values of large numbers of stars. The scatter of the individual values is not quite negligible. In Fig. 1a approximately one half of the individual dots would have been included in a band having a vertical width of one stellar magnitude, while the other half would be distributed outside this band. Clearly, this scatter of values must have an important bearing upon the fundamental problem of stellar pulsation. It means that two stars having exactly the same period may nevertheless have slightly different luminosities. This is not particularly important if our purpose is to use the period-luminosity relation in order to determine the distances of star clouds or exterior galaxies. But it undoubtedly has an important bearing upon the problem of the internal constitution of these stars.

Further significant information is contained in the numerical distribution of the stars in each of the three groups of Fig. 1a, which can be shown in the form of the frequency curves of Fig. 2. We notice that the distribution in each group is not uniform. The cluster-type stars have a pronounced maximum for absolute magnitudes of the order of −0.3, which corresponds approximately to the middle point of the left-hand branch in Fig. 1a. The frequency distributions of the other two groups are much broader, and it is formally possible to represent them as consisting of two separate distributions, each having approximately the same width as the distribution of the cluster-type stars. It is not quite clear whether these double distributions in the classical Cepheids and the Mira Ceti variables should be regarded as physically real. It may be that the only safe conclusion from Fig. 2 would be that the spread of the numbers of variables with regard to period, or absolute magnitude, is more uniform in the latter two groups than in the cluster-type variables.

Among the cluster-type variables of our galaxy RR Lyrae is the most famous representative. The distribution of these stars in the Milky Way is not uniform. They are strongly concentrated in the direction of the galactic center in Sagittarius, as is shown in Fig. 3a by Kukarkin. There is a strong excess of variables in the direction of the galactic center at longitude 330° and a corresponding diminution in density in the direction of the anticenter.

Kukarkin has next attempted to determine the distribution of the RR Lyrae variables in a plane perpendicular to the equator of our galaxy, as shown in Fig. 3b. The curves of equal star density are symmetrical with respect to the center of the galaxy and are flattened in the inner regions, but are approximately

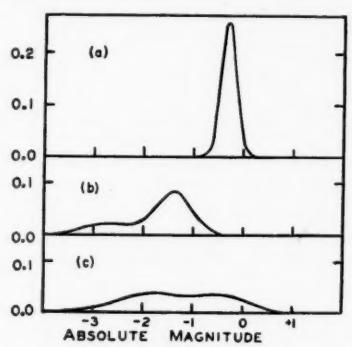


Fig. 2. The relative numbers of variable stars per unit area having different absolute magnitudes: (a) cluster-type variables; (b) classical Cepheids; (c) Mira Ceti variables.

CORRECTION

In the first part of this article, in the fourth line at the top of page 132 of the April issue, the Roman letter should have been printed as **II** instead of **I**.—ED.

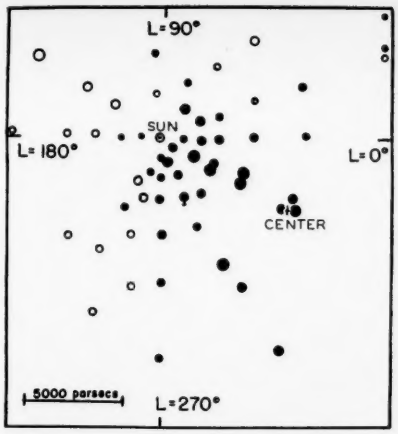


Fig. 3a. In this plot in the plane of the Milky Way, the large black dots represent regions where the density of the cluster-type variables is greatly in excess of the average. The large open circles represent regions of unusually low density in terms of these variables. The positions of the sun and the galactic center are indicated.

spherical in the outer regions. This spherical distribution resembles the distribution of the globular clusters and of the W Virginis group of classical Cepheids. Fig. 4, taken from Waldmeier's recent book on astrophysics, shows the flattened, pancake-shaped outline of the great mass of the stars of our galaxy. Both the globular clusters and the RR Lyrae variables are distributed spherically with respect to the center of the galaxy.

In Fig. 4, the shaded narrow band, in the plane of the galaxy, arranged symmetrically with respect to the solar system and located approximately at a distance of 10 kiloparsecs from the galactic center, represents the distribution of the open galactic clusters and at the same time that of the *B*-type stars and the interstellar dust and gas clouds.

According to P. P. Parenago, the RR Lyrae stars of our galaxy possess the properties of the high-velocity stars and their motions are similar to those of the globular clusters. For example, the globular clusters have a systematic velocity with respect to the stars of the solar neighborhood of 190 kilometers per second and a dispersion of velocities of plus or minus 110 kilometers per second. For the RR Lyrae variables the corresponding velocities are 150 and plus or minus 100 kilometers per second. It has been suggested that the RR Lyrae variables of our galaxy are the remnants of globular clusters which have become disintegrated in the course of cosmic time, but Kukarkin does not necessarily subscribe to this opinion. He believes that it is sufficient to suppose that both, the globular clusters and the RR Lyrae variables, have originated in the central regions of the galaxy.

It is important to realize that Baade's division of the stellar system into two populations is only a preliminary approximation. In reality there are a number of intermediate populations. For example, Kukarkin points out that most of the RR Lyrae stars belong to Population II and most of the classical Cepheids to Population I. But among the RR Lyrae variables are some which are very rarely found in globular clusters. Their periods lie between 0.425 and 0.435 day. Yet these same periods are well represented among the galactic RR Lyrae variables. Furthermore, the distribution of the periods of variables in globular clusters depends upon the degree of central concentration in the cluster: the frequency of variables with very short periods is greatest in clusters with the least amount of condensation. Kukarkin argues that the galactic RR Lyrae variables with periods between 0.425 and 0.435 day show a greater concentration toward the plane of the Milky Way than do the rest of the cluster-type variables. Perhaps they form a more flattened subsystem than do the rest of the stars, and their origin may have to be attributed to the spiral arms of the galaxy rather than to the central nucleus.

We thus find in each group of variables at least two subsystems — a flat one and a spherical one. Among the RR Lyrae variables the spherical system predominates numerically and the members of the flat system appear to us as exceptions. Among the long-period Cepheids the opposite is true: the W Virginis stars are the "exceptions" and are spherically distributed, as we noted last month.

There is a similar mixture of subsystems among the Mira Ceti variables. Kukarkin lists three subsystems: a flat one, an intermediate one which contains the majority of the stars, and a spherical one. There is a clear indication that the average periods and spectra of the members of these three groups are not the same. The systematic motions of the stars with respect to the solar neighborhood are often a useful indication of the character of their respective systems. It turns out that for periods of the order of 175 days the systematic velocity is 129 kilometers per second, while for variables with longer periods it decreases, until for 350 days it is about 10 kilometers per second. Hence, the shorter periods seem to be associated with the characteristics of spherical subsystems,

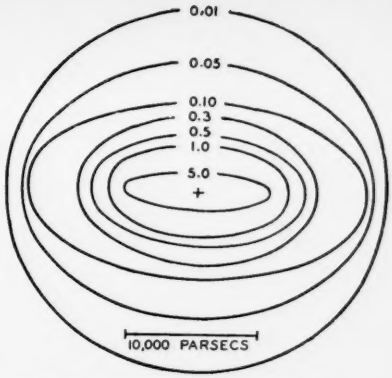


Fig. 3b. The smoothed distribution in space density of the cluster-type variables in a plane at right angles to the Milky Way, and looking from the sun toward the galactic center, which is marked by the cross.

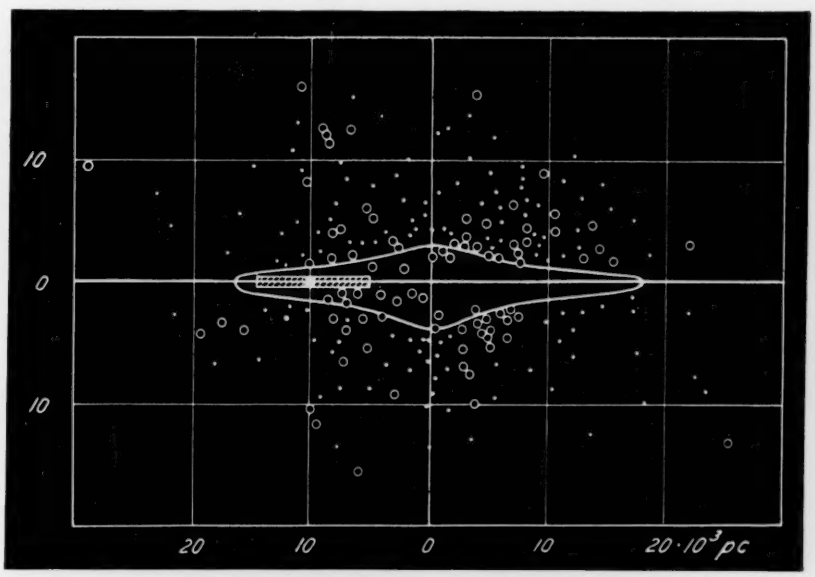


Fig. 4. The distribution of the globular clusters (open circles) and galactic cluster-type variables (small dots) with respect to the stellar system, whose center is at zero co-ordinates, and with respect to the solar system, which in the diagram is located to the left of the galactic center. The scale is in thousands of parsecs (kiloparsecs). Note that the distribution of the globular clusters as well as of the cluster-type variables is approximately spherical.

while the longer periods occur in the flat subsystems.

The great variety of the subsystems among the variable stars of the great sequence is really quite bewildering and compels us to abandon the simplicity of the earlier investigations in stellar statistics which had led to the pancake-shaped model of the galaxy. But we can still maintain Baade's division of the stars into two populations as a rough approximation, if we remember that there are other, intermediate populations. In Fig. 5 the two extreme types of population are shown in the form of a Hertzsprung-Russell diagram. The solid lines represent the "old" stars of Population II and the dotted lines the "young" stars of Population I. Both populations contain stars of essentially the same spectral classes, but their luminosities are as a rule quite different, and their spectra show appreciable differences (such as abnormally weak hydrogen lines among the RR Lyrae variables). According to the work of M. Schwarzschild, we expect to find the cluster-type variables in a narrow band of the diagram, along the horizontal sequence of Population II. Where, then, should we look for the members of the flattened subsystem of the RR Lyrae group? If they belong to Population I and are of spectral class between *A*0 and *F*0, we are tempted to place them within the main sequence. But surely they do not really belong there. At least one of them, SW Andromedae, was described by Munch and Terrazas as having the spectrum of a normal giant.

Everything seems to suggest that the

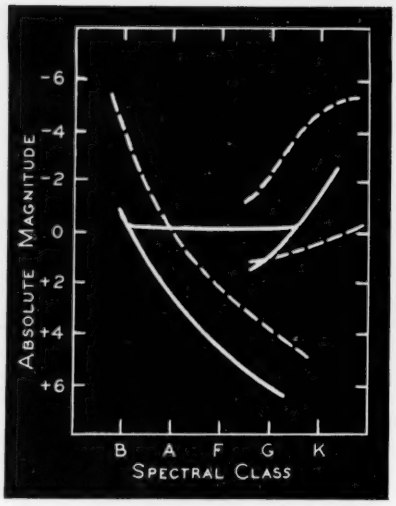


Fig. 5. A schematic representation of the Hertzsprung-Russell diagram for the two principal populations of stars. The dotted curves represent Population I, which is believed to consist of young stars and is characteristic of the solar neighborhood. The solid curves show Population II, consisting of stars thought to be old, and which are most numerous in the nucleus of our galaxy, in globular clusters, and in elliptical galaxies.

separation into two populations must be regarded as a statistical phenomenon, and that there are all sorts of transitions between them. According to D. M. Popper the brightest stars of the globular clusters M3 and M13 have spectral types *O*8 and *B*5, respectively, although as a rule the globular clusters contain no early-type stars. With the evidence from the variable stars, we conclude that there is no complete absence in the clusters of objects normally attributed to the "young" sequence of Population I. Similarly, in regions usually attributed to Population I we find representatives of the "old" sequence of spherical distributions. As Dr. Shapley remarked, after reading last month's article, this difficulty is encountered also among the red giants of the globular clusters: Their great luminosities indicate a rapid process of energy generation. By any of the known nuclear transformations, the available supply of energy would be sufficient to maintain them in their present condition for not more than 100 million years — they are "young" stars, even though they occur in formations that are mostly composed of "old" stars.

In some respects Kukarkin's book poses more questions than it solves. We must recognize that the problem of the ages of the stars is not as simple as it looked a few years ago. It is still tempting to think of the spherical distributions in our galaxy as representing objects having a different origin and evolution than the members of the flattened distributions. But it is no longer possible, without qualification, to attribute to them vastly different ages.

There are some, at present rather vague, indications that variables belonging to the same subsystems, in and out of globular clusters, have somewhat different light curves, spectra, and radial velocities. More detailed studies of these differences promise to give us results of great interest.

AMERICAN ASTRONOMERS REPORT

(Continued from page 161)

they must be very small stars, and in certain cases, as of the companion of Sirius, are known to have very high densities. Dr. W. J. Luyten, of the University of Minnesota, described the search for white dwarfs he has carried on for several decades, and discussed the need for more observational data before the true physical character of these objects can be determined. One hundred and eleven white dwarfs are now known, a majority as a result of this unremitting search. His work has been done chiefly with plates taken at the Cordoba Observatory in Argentina, at several stations of Harvard Observatory, and at the Steward Observatory in Arizona.

The symposium was concluded by Dr. G. P. Kuiper, of Yerkes and McDonald Observatories, who discussed the physical nature of the white dwarfs and the subdwarfs. He described observations of Procyon and its companion whereby he has determined that the companion is definitely a white dwarf.

AURORA AUSTRALIS

The lifelong work of Carl Stoermer of Norway has resulted in considerable knowledge of aurorae in the Northern Hemisphere. Most of them are found to occur at about 65 miles, but the total range of observed heights is from 44 to 690 miles. Much fewer observations are available in the Southern Hemisphere, and even the location of the auroral zone (the latitude of maximum frequency) is not well established. In 1931 M. Geddes commenced systematic observations, which since his death have been carried out under the direction of the Carter Observatory in New Zealand, established in 1939. I. L. Thomsen, of that observatory, has recently issued a "Manual for Visual Observations of the Aurora Australis" to aid amateurs, whose assistance is badly needed in furthering this work.

Northern and southern lights are not independent. Presumably spectacular displays occur simultaneously in both hemispheres, although it remains to be determined just how close the coincidence really is. In the south, the auroral zone seems to undergo considerable expansion and contraction with the sunspot cycle, and many more observations are needed for the elucidation of this and related phenomena.

The southern observations are more difficult to obtain in large numbers because of the greater prevalence of water over land areas in latitudes between 30° south and the Antarctic continent. Moreover, the south magnetic pole is far from the pole of rotation, leaving only the very southernmost part of South America suitably located for all but the most spectacular displays. Thus, it is up to the New Zealand and Australian observers to obtain the bulk of the southern data that can be acquired.

MEETINGS AT SALT LAKE CITY

On June 22, 1950, a meeting of the Astronomical Society of the Pacific will be held in conjunction with the meeting of the Pacific division of the American Association for the Advancement of Science. Part of the program will be devoted to features of special interest to the amateur. The chairman of the local committee is Dr. Richard N. Thomas, of the University of Utah.

NEWS NOTES

By Dorrit Hoffleit

PLANET TRANS-PLUTO?

Unique in the history of astronomy would be the discovery of a planet predicted from the observations of comets. In an article in the German popular astronomical journal, *Sternenwelt,* February, 1950, Karl Schuette, of Munich, finds need for a trans-Plutonian planet, approximately 77 astronomical units from the sun, to account for his discovery of a new family of comets.

Schuette had been examining the distributions of all the well-determined orbits of comets with periods less than 80 years and found that, with the single exception of Comet Encke (period 3.3 years, aphelion distance 4.1 A.U.), all of these comets appear to belong to the discrete "families" of the outer planets. Jupiter has the largest family with 52 known members, Saturn six, Uranus three, and Neptune eight. The aphelion distances of these comets average about 10 per cent greater than the distances of the planets that control them.

In the case of Jupiter, it is of particular interest to note that the cometary aphelia are preponderant in the direction of Jupiter's own aphelion. The planet, moving more slowly at its aphelion than at perihelion, in accordance with the law of areas, then has more time to capture comets as they speed by.

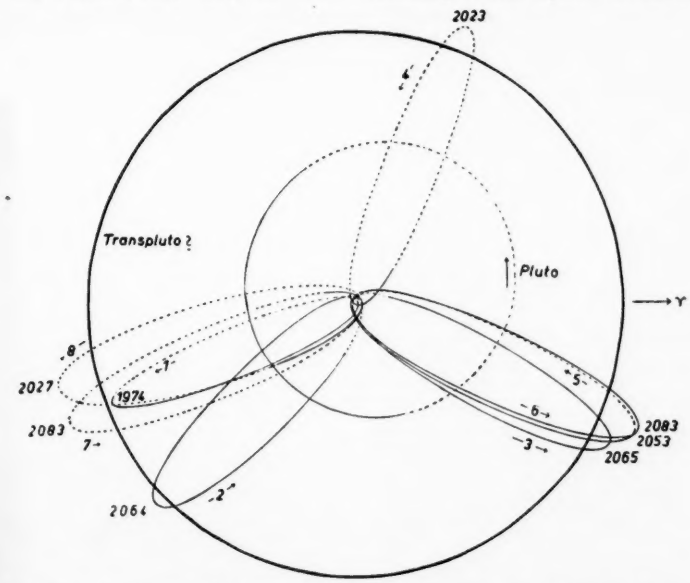
No comets were found with aphelion distances strikingly intermediate between those of the major planets. Turning his attention, then, to the longer-period comets, Schuette discovered two new, more distant families. He found that five comets belong to a Pluto family: 1862 III Tuttle-Swift, 1889 III Barnard, 1907 II Grigg-Mellish, 1917 I Mellish, and 1939 VI Rigollet. Their periods range from 119.6 to 164.3 years and their aphelion distances from 47.6 to 59.0 A.U. Beyond this group there is a gap similar to those between the other families, and then a family of eight comets having a mean aphelion distance of 84.8 A.U. and periods between 234 and 306 years.

Noting again that the average aphelion distances of comet families are some 10 per cent greater than the distances of their foster-parents, Schuette points out that a planet which might have captured these eight comets would be about 77 A.U. from the sun. This distance is in excellent agreement with what might be predicted from the Titus-Bode "law." The position of the hypothetical planet in its orbit cannot, however, be predicted from the positions of the cometary orbits.

CALIFORNIUM

Nuclear physicists at the University of California, who in January reported the discovery of berkelium, element No. 97, have now produced element No. 98. They have named it californium, in honor of their university and their state. It is produced by bombarding the element curium (No. 96) with 35 million electron-volt alpha particles (nuclei of helium atoms) in the 60-inch cyclotron.

Californium is very scarce. Not enough of it has been made for any to be visible. It is intensely radioactive. Within 45 minutes half of it decays by emitting alpha particles spontaneously, becoming curium again. It has no practical value for military purposes, but it does add to man's knowledge of the structure of matter.



The family of comets which Karl Schuette believes may belong to a trans-Plutonian planet are: 1, 1857 IV C. H. F. Peters; 2, 1932 X Dodwell-Forbes; 3, 1931 III Nagata; 4, 1885 III Brooks; 5, 1905 III Giacobini; 6, 1932 I Houghton-Ensor; 7, 1932 V Peltier-Whipple; 8, 1874 IV Coggia. "Sternenwelt" diagram.

AURORAL HYDROGEN

In addition to the well-known features of the auroral spectrum (oxygen and nitrogen bands and forbidden nitrogen lines), Dr. C. W. Gartlein, of Cornell University, finds three hydrogen lines at 6563, 4861, and 4340 angstroms. The first two of these had previously been observed by Vegard, but the current work adds needed confirmation.

Dr. Gartlein, whose program is sponsored partly by the National Geographic Society, observed that the intensities of the hydrogen lines vary in step with one another but out of step with lines of other elements. Moreover, the hydrogen lines are extremely broad, and in the *Transactions* of the American Geophysical Union Dr. Gartlein states:

"The values of pressure, temperature, magnetic field or electric field required to produce such broadening are so great that we know they cannot occur in the upper atmosphere. Thus we believe the broadness of these lines can be ascribed only to Doppler broadening due to line of sight motion when the atoms are radiating."

Velocities differing by as much as 400 kilometers per second from their mean are observed. The hydrogen lines appear strongest on spectra exposed just before and during great auroral outbursts.

Previously it had been postulated by Eckersley that protons (hydrogen nuclei) from the sun penetrate our atmosphere, causing ionospheric disturbances. The present observations, in confirmation of this theory, indicate that the auroral hydrogen "is of solar origin and a primary cause of some aurora outbursts and magnetic storms."

In the CURRENT JOURNALS

Astronomy in South Africa, by David S. Evans, *Endeavour,* January, 1950. "South Africa has been called the astronomer's paradise, and it certainly has more active observatories for its population than any other region of the world."

The Changing Climate, by George H. T. Kimble, *Scientific American,* April, 1950. "There is little doubt that the averages of conditions which make up the weather have changed during the course of history. What about man's efforts to alter them further?"

The Compensation for Seeing in Stellar Photoelectric Spectrophotometry, by W. A. Hiltner and A. D. Code, *Journal,* Optical Society of America, March, 1950. "It has become increasingly important to obtain intensities (of spectral lines) of appreciably higher accuracy than is possible by the usual methods employed in spectrophotometry."

Amateur Astronomers

Wellesley Convention To Have Representative Attendance

ABOUT 120 persons had registered their intention of attending the Wellesley convention of the Astronomical League by the initial deadline of April 1st. The convention, to be held July 1-4 on the campus of the well-known Massachusetts college, is open to all amateur and professional astronomers, whether members of the Astronomical League, members of a non-affiliated society, or just persons interested in astronomy.

Geographical representation will be excellent at the convention, as 16 states and the District of Columbia are already heard from, as well as Canada and Cuba. Several families are coming, including one from Texas and that of Charles H. LeRoy, president of the Astronomical League.

Thanks to the large initial registration, it has been possible for the convention committee to make the required **minimum** reservation with Wellesley College officials, but the **maximum** number that can be housed in Tower Court is over 200. Therefore, all others interested in attending are urged to make reservations as soon as possible. A deposit of $5.00 **for each person,** with checks and money orders made payable to the **Bond Astronomical Club,** is required for accommodations in Tower Court. A few rooms with double-decker beds or two single beds are available; the rest are single; and it will aid us if you specify which you prefer. Send your reservation to the undersigned. All reservations are being acknowledged by postcard.

The total cost for room and meals from Saturday evening (after supper), July 1st, through breakfast Tuesday, July 4th, will be $15.50, plus the $1.00 voluntary registration fee, for all persons making reservations during April and May. More detailed information about these matters, and the general program of the convention, may be found in the March issue of **Sky and Telescope,** and in the March number of the Astronomical League **Bulletin.**

The following list comprises those who registered by the April 1st deadline:

CONNECTICUT: *Middle Haddam*, Walter Fellows. *North Haven*, Mr. and Mrs. Frank Velardi.

DISTRICT OF COLUMBIA: Jewell Boling, Sadie C. Coxen, Miles Davis, Mrs. Dorothy S. Geare, Margaret B. Glock, I. H. Halpern, Louise Horton, John E. Lankford, Estella Miller, Janet Perkins, Mabel Sterns, G. R. Wright.

GEORGIA: *Decatur*, Dr. and Mrs. W. A. Calder and family.

INDIANA: *Indianapolis*, John Beyersdorfer.

KENTUCKY: *Louisville*, Mr. and Mrs. Charles Strull. *Newport*, Homer D. Groendyke, Jr.

MARYLAND: *Cheverly*, H. Leroy Benfer. *Kensington*, Irene H. Warthen. *Silver Spring*, Grace C. Scholz.

MASSACHUSETTS: *Belmont*, Mr. and Mrs. C. A. Federer, Jr., Mrs. Lester von Thurn. *Cambridge*, Mrs. Nancy R. Bolton and Miss Bolton, Betty G. Dodd, Mrs. A. F. Downing, Mrs. Margaret W. Mayall. *Everett*, Mr. and Mrs. Lauchlin J. MacKenzie, Audrey E. Wyman. *Jamaica Plain*, Fred A. Pflug. *Lexington*, Mr. and Mrs. Chester Cook. *Longmeadow*, Rolland R. LaPelle. *Lynn*, Homer D. Ricker. *Milton*, Gertrude Ehrlicher, Katharine H. Hendrie. *Quincy*, Harry B. Chase. *Wellesley*, Wallace V. Plummer.

MICHIGAN: *Detroit*, Mr. and Mrs. Clarence E. Bell, Mrs. Olive Grunow. *Highland Park*, Kyrren Kittleson. *Northville*, Patricia Altenberg, Mr. and Mrs. Clifford Stevens and family. *Pontiac*, Mrs. Mabel Chircop.

MISSISSIPPI: *Vicksburg*, Mrs. Albert M. Bonelli.

MISSOURI: *St. Joseph*, Jesse Moore.

NEW JERSEY: *Dunellen*, Mr. and Mrs. Stanley Brower. *Hawthorne*, William A. Reid. *Paterson*, Amelia D. White.

NEW YORK: *Brooklyn*, Anna Vafiades. *Buffalo*, James F. Westland. *Long Island City*, Jane E. Burden, Charles Cuevas. *New York*, Mr. and Mrs. Leon E. Gold, Mr. and Mrs. Arthur I. Lee, Edward Oravec, Helen Richman, Mr. and Mrs. Abel M. Silvan, Albert Richard Vogeler, Kenneth Weitzenhoffer, Mr. and Mrs. William F. Wurster. *Oceanside*, Mr. and Mrs. Ted Zaph. *Utica*, John Zimm.

PENNSYLVANIA: *Erie*, Harry F. Lindsay. *Philadelphia*, Edwin F. Bailey, Emil Klein, Eleanor Vadala, Joseph Mark Van Horn. *North Braddock*, Gordon Urban. *Pittsburgh*, Mrs. Burcik and Miss Mary Burcik, Mr. and Mrs. Charles H. LeRoy and family, Mr. and Mrs. D. F. Mathe and family, Mrs. Ida C. Wilson.

TEXAS: *Ft. Worth*, Dr. and Mrs. Herman Sehested and family.

VIRGINIA: *Arlington*, Robert W. Rhynsburger. *Newport News*, Mr. and Mrs. R. J. Wicke. *Ware Neck*, Dr. L. L. Rice.

WEST VIRGINIA: *McMechen*. Mr. and Mrs. Stewart Freeman.

WISCONSIN: *Milwaukee*, Cora E. Zemlock. *Monroe*, Mr. and Mrs. Perle G. Guess. *Oshkosh*, Mr. and Mrs. Ralph N. Buckstaff. *Wauwatosa*, Mr. and Mrs. Roy L. Dodd.

CANADA: *Montreal*, Frank J. deKinder, Isabel K. Williamson.

CUBA: *Santiago de Cuba*, Miguel Cabanach, Ricardo Cabanach.

CHARLES A. FEDERER, JR.
Chairman, Wellesley Convention
Harvard College Observatory
Cambridge 38, Mass.

Part of the Wellesley College campus and the surrounding country, photographed from the air. Whitin Observatory is at the right, and Tower Court, identified by its square tower, is toward the left, with Lake Waban nearby.

THIS MONTH'S MEETINGS

Cambridge, Mass.: The annual meeting of the Bond Astronomical Club will be held on Thursday, May 4th, a dinner meeting at the Bella Vista Restaurant. Dr. A. C. Banerji, University of Allahabad, will speak on "Ancient Astronomy in India."

Chicago, Ill.: Dr. Gerard P. Kuiper, of Yerkes and McDonald Observatories, will discuss "The Origin of the Solar System," at the May 9th meeting of the Burnham Astronomical Society, at 8 p.m. in the Chicago Academy of Sciences auditorium.

Cleveland, Ohio: The annual dinner meeting of the Cleveland Astronomical Society will be held on May 5th, and Dr. Roderic M. Scott, of the Perkin-Elmer Corporation, will speak at 8 p.m. on "Post War Astronomical Instruments."

Dallas, Tex.: On Monday, May 22nd, the Texas Astronomical Society will continue the study of constellations and other astronomical subjects started in April. The field meeting will be held near the Cedar Crest Country Club. The public is invited.

Detroit, Mich.: At the May 14th meeting of the Detroit Astronomical Society, Dr. Helen W. Dodson, of the McMath-Hulbert Observatory, will give an illustrated talk on our nearest neighbor, the moon. The meeting will be at 3:00 p.m. in State Hall, Wayne University.

Geneva, Ill.: At the May 2nd meeting of the Fox Valley Astronomical Society, 8 p.m. in the Geneva City Hall, there will be demonstrations of mirror grinding and telescope making by members of the telescope builders' committee, and also sketches and demonstrations of astronomical models.

Indianapolis, Ind.: The board of officers of the Indiana Astronomical Society will conduct its annual "Information Please" at the May 7th meeting, to be held at 2:15 p.m. in Cropsey Hall.

Kalamazoo, Mich.: Meeting at the home of Dr. and Mrs. Paul Rood, 1615 Cambridge Road, on May 20th at 8 o'clock, the Kalamazoo Amateur Astronomical Association will hear Jerome Korman speak on "A Theory of the Origin of the Solar System."

New York, N. Y.: The annual meeting of the Amateur Astronomers Association will be held on May 17th, 8 o'clock in the American Museum of Natural History. There will be motion pictures, reports of officers and committees, elections, and entertainment. The annual field trip of the association is scheduled for May 30th.

Philadelphia, Pa.: On May 12th, Dr. E. Witmer will speak at the meeting of the Rittenhouse Astronomical Society, 8 p.m. in the Morgan physics laboratory of the University of Pennsylvania.

St. Paul, Minn.: The St. Paul Telescope Club will meet May 10th at 8 p.m. in Carnegie Science Hall, Macalester College. A three-member panel will discuss Immanuel Velikovsky's "Worlds in Collision," with George R. Wagner, Dr. Sherman W. Schultz, and Mrs. W. A. Hooper participating. At the May 24th meeting, Dr. S. C. Moske will talk on "The Moon."

Stamford, Conn.: Mrs. Maud W. Makemson, of Vassar College Observatory, will speak on "The Beginnings of Astronomy" at the meeting of the Stamford Museum Amateur Astronomers on May 19th at 8 p.m.

Washington, D. C.: The National Capital Astronomers will meet on Saturday, May 20th, 8 p.m. in the Commerce Building auditorium, instead of on the usual first Saturday, to avoid conflict with the Middle East regional convention. For the first time in the society's history, the lecture meeting will be taken over by amateur members. John Lankford, Jr., Miles Davis, R. W. Rhynsburger, and Dr. S. T. Wells will speak, respectively, on "When Stars Explode," "Methods of Observing Variable Stars," "The Astronomical Unit and Its Measurement," and "The Moon's Course in Relationship to the Sun."

ASTRONOMICAL INFORMATION SHEETS

Mailing No. 108, sheets 363-368, of the Astronomical Information Sheets has been distributed under date of March 15, 1950, by the Sacramento Valley Astronomical Society (see page 61, January issue). It opens with a letter to readers signed by Mrs. G. Bruce Blair, widow of the founder of this service to observing amateurs.

At a recent meeting, the Sacramento Valley society elected officers as follows: president, Paul H. Steele; vice-president, Carl W. Anderson; secretary, Mrs. Helen Schopke; treasurer, Mrs. June Breton.

The Samuel J. Smythe award for outstanding student work in astronomy during 1949 was presented to Donald O'Toole, of Vallejo, Calif.

MID-CENTRAL STATES AMATEUR CONVENTION

SPONSORED by the Kansas City Amateur Astronomers and Telescope Makers and the Central Missouri Amateur Astronomers, of Fayette, a convention of amateur astronomers will be held in Kansas City, Mo., at the Kansas City Museum, 3218 Gladstone Blvd., on June 17-18. The idea of the convention is to stimulate as much interest in amateur astronomy in this region as possible, and we hope to make an annual affair of it. To my knowledge no conference of this nature has been attempted so far in this area.

The program opens Saturday, June 17th, with registration from 9 a.m. to noon. Registration fee will be $1.00, and the cost for the Saturday evening banquet is $2.00. Displays will be set up during the morning hours. Homemade telescopes, astro cameras, photos, drawings, meteorite collections, and so on, may be exhibited, and a prize will be awarded for the best-designed homemade telescope.

After lunch and a welcome to delegates by the host society officers, there will be a papers session from 1:30 to 3:30, followed by inspection of exhibits.

The banquet at the Melrose Methodist Church (two blocks from the museum) will be at 6 o'clock, followed by an address by a professional astronomer. From 7:30 on, demonstrations of the newly installed Spitz planetarium at the museum, and a star party outdoors, will run concurrently. In case of cloudy weather, six astronomical movies will be shown.

On Sunday at 9 a.m., the convention will decide on a meeting place for 1951. There will be discussion of the formation of a new region of the Astronomical League. The latter part of the morning will be a free period, and from 1 to 2 o'clock organized societies represented will report on their activities. A conducted tour of the museum from 2 until 3 closes the program.

Accommodations are the responsibility of the individual. Further information about the program and a hotel list may be obtained from the undersigned, who is acting as convention program chairman. Any interested amateur or professional astronomer is invited to attend, and we hope particularly to reach those from Kansas, Missouri, Nebraska, western Iowa, western Illinois, northern Arkansas, northern Oklahoma, and eastern Colorado.

RUSSELL C. MAAG, chairman
Central Missouri Amateur Astronomers
611 Bluff St., Fulton, Mo.

NEW LEAGUE MEMBER

The Richmond Astronomical Society, with 19 members, has voted to join the Astronomical League. The secretary-treasurer of the group is Miss Lillian G. Sievers, 4018 Clinton Ave., Richmond 27, Va.

LETTERS

Sir:

At this writing (March 11th) I have just returned from Mt. Hamilton and Lick Observatory where I had a fine view of Canopus. I am prompted to write this letter in answer to the question in "Stars for February," and to Mr. Dinwiddie's letter published in the March issue.

We first observed Canopus about 7:00 p.m. PST, March 11th, from an altitude of some 3,000 feet, and then saw it intermittently on our way to the observatory, which is at 4,200 feet. It then appeared about 1½° above the horizon. The latitude of Lick Observatory is +37° 20'.4.

JOEL PALMER
Rt. 1, Box 67, Saratoga, Calif.

Sir:

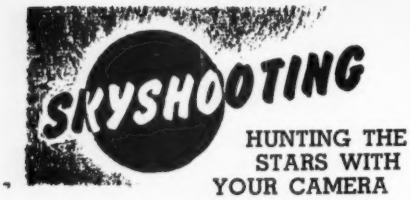
I have observed Canopus for a number of years from Lookout Mountain (Chattanooga), Tenn. From about January 20th on through most of February, this great star may be seen easily from this latitude. However, the atmospheric conditions must be favorable, and it is of advantage to view the star from an eminence from which the land drops sharply away toward the south. Canopus then rides well above the horizon, almost due south of Sirius.

JOSHUA B. WARNER
117 Highland St.
Lookout Mountain, Tenn.

Sir:

Re the note on approximate sidereal time, by H. M. Priest (January issue, page 72), we use a similar application of this rule when taking the Pointers of the Plough as a star clock.

(Continued on page 170)



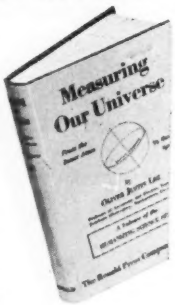
by R. Newton and Margaret L. Mayall

"The book should find its way into every astronomical library and stimulate the interest of many amateur photographers as well as telescope enthusiasts." HARLAN T. STETSON

For anyone with a camera who wants some of the fun of photographing the heavens. This exciting book tells what there is in the heavens to photograph and how to 'shoot' it. The book contains data on photographic details as well as ample material on astronomy, telescopes, and other equipment. Excellent photographs prove that the amateur *can* produce astronomical pictures of beauty and scientific value. *Illustrated.* **$3.75**

MEASURING Our UNIVERSE

by Oliver Justin Lee



A distinguished astronomer tells you in this new book what scientists know about distances, and how they know it . . . what methods they use, and the importance of accuracy in their work. Here is the story of man's long struggle with the problem of measuring distances. *Illustrated.* **$3.00**

SUNSPOTS in ACTION

by Harlan True Stetson

Here is the stranger-than-fiction story of how explosions on the sun's surface affect our life on earth . . . told by a widely acclaimed authority. *Nobel Prize Winner Sir Edward V. Appleton says*: "Indeed, the reader could not have a more learned or friendly guide." It is a book for everyone who would keep abreast of scientific advance in the field of cosmic-terrestrial relations. *Illustrated.* **$3.50**

PHYSICS TELLS WHY

by Overton Luhr

Here is a valuable understanding of how the basic laws of physics apply to today's inventions, new developments and natural phenomena. To quote the *American Scientist*, "One of the most charming, most popular, and most highly praised volumes in its own or any field." *Illustrated.* **$3.75**

THE RONALD PRESS COMPANY
15 East 26th Street, New York 10, N. Y.

SEND ME the books checked. Within 5 days I will either remit full price, plus mailing charge, or return the books. (We pay delivery if you remit with order.)

- ☐ Skyshooting, *Mayall-Mayall* $3.75
- ☐ Measuring Our Universe, *Lee* 3.00
- ☐ Sunspots in Action, *Stetson* 3.50
- ☐ Physics Tells Why, *Luhr* 3.75

Name .....

Address .....

City ..... **Zone** .... **State** .....

M 212

BOOKS AND THE SKY

TERRESTRIAL MAGNETISM AND ELECTRICITY

Edited by **J. A. Fleming.** Dover Publications, New York, 1949. 794 pages. $4.95.

STUDIES of electromagnetic phenomena on an astronomical scale are still relatively few. The subject is a young one, but there are good reasons for believing that it will grow rapidly in size and importance. For as astronomical bodies come under ever closer scrutiny, we recognize more and more often the occurrence of phenomena that can be adequately described only in terms of electric charges, currents, and electromagnetic fields. The sun's corona, the prominences, the sunspots; the peculiar **A** stars and the spectrum variables; the interstellar dust; and the cosmic rays: In all these objects of astronomical inquiry, large-scale electromagnetic effects are now known to play a significant role.

In their attempts to understand how electromagnetic effects operate on cosmic bodies, astronomers will undoubtedly be guided in large measure by the very impressive work already done on the magnetic and electrical properties of the earth. In this respect, ours is the only astronomical body studied until now in any detail. **Terrestrial Magnetism and Electricity** is an exciting and stimulating account of the main results of this study.

The book was originally published in 1939 as Volume VIII of the distinguished "series of bulletins on The Physics of the Earth," prepared by a committee of the National Research Council "to give to the reader, presumably a scientist but not a specialist in the subject, an idea of its present status together with a forward-looking summary of its outstanding problems." The present edition is a 1949 reprint with corrections. With J. A. Fleming as editor, 14 authorities actively engaged in research have contributed 12 chapters on various aspects of the main subject, plus a bibliography of over 1,500 titles representing the more important contributions to the year 1937.

The earth has a magnetic field nearly equivalent to the one that would result if it contained a powerful half-pound bar magnet in every cubic yard of its bulk. But such magnets do not exist. In the first chapter, Dr. Fleming describes the general features of the earth's magnetism and its changes with time. The description summarizes observations made by the Department of Terrestrial Magnetism, Carnegie Institution of Washington, at more than 10,000 stations widely scattered over land and sea. The observations indicate large secular changes of the magnetic intensity, particularly in certain regions of the earth; moderate diurnal changes; small lunar-day and annual changes; and short-lived, more or less irregular changes called magnetic storms. "A large part of the changes," says Dr. Fleming, "...has its origin...from silent and titanic forces ceaselessly at work deep within the Earth . . . ."

In Chapter II, H. F. Johnston, Fleming, and H. E. McComb give a detailed account of the instruments used for measuring the earth's magnetic field. Chapter III, by C. A. Heiland, is a description of the methods of magnetic prospecting, by means of which hidden deposits of ore, oil, even meteorites, have been mapped through their perturbations of the magnetic field at the surface above them.

Chapter IV, by O. H. Gish, begins with the classical experiments of Benjamin Franklin on atmospheric electricity, and goes on to a detailed discussion of modern knowledge of potential gradients and currents in the air. Wherever fair weather prevails over the surface of the earth, positive ions drift from the air to the ground at a net rate of about 2,000 per square centimeter per second. These ions must be removed from the surface at the same rate, or negative ions must be supplied in equal amount, for otherwise the earth would soon acquire an electrostatic charge that would stop the current flow. But the nature of this supply current is still obscure.

Next, the instruments used in studies of atmospheric electricity are described by O. W. Torreson, and the currents that flow through the earth itself are discussed by W. J. Rooney. The earth currents change when the magnetic field changes; the air currents do not.

NEW BOOKS RECEIVED

THE PLANET MARS, *Gerard de Vaucouleurs*, 1950, *Faber and Faber, Ltd.* 87 pages. 10s 6d.

This is a translation by Patrick A. Moore of a book devoted to a review of observational data about Mars, and to evaluation of the problems of canals and life on the ruddy planet.

A CONCISE HISTORY OF ASTRONOMY, *Peter Doig*, 1950, *Chapman and Hall, Ltd.* 320 pages. 21s.

The author, editor of the *Journal* of the BAA, traces the history of the development of the science from "The Oldest Astronomy" through "Twentieth Century." The foreword is by the Astronomer Royal, Sir Harold Spencer Jones.

OUT OF MY LATER YEARS, *Albert Einstein*, 1950, *Philosophical Library*. 282 pages. $4.75.

A collection of writings from the pen of Albert Einstein covering the years 1934-1950 represents not only discussion of scientific questions, but personalities and social problems. This is a second volume of collected essays; the first was published under the title *The World As I See It*, and covered the years 1922 to 1934.

REFLECTIONS OF A PHYSICIST, *P. W. Bridgman*, 1950, *Philosophical Library*. 392 pages. $5.00.

A collection of the non-technical writings of Nobel prize winner Bridgman, grouped under the headings, General Points of View, Applications to Scientific Situations, Primarily Social, Specific Situations, Prophetic.

CLIMATE THROUGH THE AGES, *C. E. P. Brooks*, 1949, *McGraw-Hill*. 395 pages. $4.50.

A revision of a work first published in 1926, this book should be of interest to all students of meteorology, geography, and geology, and it contains material of value to archeologists and historians.

In Chapter VII, Dr. McNish begins with a lucid exposition of the method of harmonic analysis, as used originally by Gauss to find the source of the earth's magnetic field. The conclusion is that all but two or three per cent of the "permanent" field originates within the earth. But the fluctuating part of the field originates principally in extensive electric currents flowing in the very high atmosphere, or even well beyond its outermost fringes. J. Bartels continues this discussion and summarizes the evidence for the solar origin of magnetic storms.

The methods and results of radio exploration of the ionosphere are described by L. V. Berkner. With the sun in the zenith, the atmosphere normally shows three banks of heavy ionization, at heights of about 100, 200, and 300 kilometers, respectively. The ion density is highest in the uppermost (F2) layer, where one out of every 1,000 molecules (or atoms) is ionized. At sea level, the ionization per molecule is 10 million million times less.

The next chapter, by E. O. Hulburt, on the upper atmosphere, was for this reviewer the most exciting and delightful in the book. Explanations of the F-layer ionization in terms of ultraviolet absorption by oxygen and nitrogen atoms, and atmospheric theories of certain ionospheric disturbances, magnetic storms, and even of the zodiacal light, are given a spicy and compact treatment. L. Vegard, in Chapter XI, describes the positions, forms, incidence, and spectra of the aurora, and the solar ion-spray interpretations of Birkeland and Stoermer.

In the last chapter preceding the bibliography, B. F. J. Schonland writes on thunder clouds, shower clouds, and their electrical effects.

The book is one that should appeal to any astronomer, amateur or professional. Extended sections are quite technical, and will be skipped by many readers. But the authors are to be congratulated for presenting the subject in a manner entirely appropriate to the avowed purpose of the "Physics of the Earth" series, as quoted earlier in this review. In many important respects, the various articles cannot fail to be badly out of date. However, they should serve admirably to prepare the reader for dipping into some of the more recent literature on the subject, and the astronomer for setting about the study of phenomena unfamiliar to him in the stars, but already an old and well-discussed story to the men who study the astronomical body Earth.

ARMIN J. DEUTSCH
Harvard College Observatory

SCIENTIFIC AUTOBIOGRAPHY AND OTHER PAPERS

Max Planck. Philosophical Library, New York, 1949. 192 pages. $3.75.

THE Philosophical Library did a real service to the student of the history of science by having published, in a modest volume with the above title, a translation from the German of four papers and essays on the philosophy of science, written by Max Planck in the last decade of his long life, together with an outline of his life. Planck's views on the philosophy of science, as found in his essays, scarcely reflect any novelty over his previous writings on this subject. It is the posthumously published autobiography which is the main feature of interest of the present volume and which, brief as it is, contains many a point that is bound to arrest our attention and give us matter for thought.

Thus, while commenting on the vicissitudes of his early academic life, Planck observes, "This experience gave me also an opportunity to learn a fact—a remarkable one, in my opinion: A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."

We have no reason to disbelieve the veracity of this observation—in Planck's day; but even a pessimist would not assert that it is true today, at least not in physical science. This change in attitude toward objective truth, which must have thus taken place in the past 50 or 60 years, is indeed a remarkable achievement. Yet, speaking of bygone days, was Planck himself any more broad-minded in this respect than his older colleagues? When in the first decade of our century, Einstein's theory of relativity entered the arena of contesting physical theories, Planck became an early adherent and did much, in fact, to secure Einstein's appointment to Berlin. And yet, as Philipp Frank relates in his admirable biography of Einstein, "Einstein could never get rid of the feeling that the emotion and ideas of a man like Planck were actually opposed to his own, and that it was only by means of rational arguments that Planck forced himself to say or do something in agreement with Einstein's views."

As the world knows, Max Planck, the cool and conservative Prussian, became a revolutionary at the relatively advanced age of 42, when he enunciated the famous radiation law that proved to be the cornerstone of the quantum theory of radiation. This discovery, as Planck himself describes at some length in his autobiography, was not the result of an inspired intuition or bold imagination, but was ar-

ASTRONOMICAL SERVICES FOR YOU

You will want the new set of Astronomy Charts covering eclipses beyond the year 2000, and many other subjects.

For professional and amateur astronomers, for educators, lecturers, museums, libraries.

Two sets of Astronomical Charts (25 charts in each set), 8½ x 11, punched for loose-leaf notebook ..... $3.00 either set

Large Wall Charts, 27" x 35" (50 available), ... each $3.00

24 35-mm. SLIDES in sturdy glass mounts, chart slides and Mt. Wilson pictures, $8.50

Save by a combined order:

Both chart sets (8½ x 11) ..... $ 5.75
Either chart set and slide set $11.00
Two chart sets and slide set $13.75

We pay postage.

May we send you our new circular?

ASTRONOMY CHARTED
4 Mason Street, Worcester 2, Mass., U.S.A.

Out Of My Later Years

by

ALBERT EINSTEIN

THIS is the first new collection of papers, since 1936, by the eminent physicist. A considerable number of these essays have never been published before in any language.

FROM THE TABLE OF CONTENTS

The Theory of Relativity $E = MC^2$
Time, Space and Gravitation
Physics and Reality
The Fundaments of Theoretical Physics
The Common Language of Science
The Laws of Science and the Laws of Ethics
An Elementary Derivation of the Equivalence of Mass and Energy
Science and Civilization
A Message to Intellectuals
A Reply to Soviet Scientists
Atomic War or Peace
Military Intrusion in Science

Isaac Newton — Johannes Kepler
Marie Curie — Max Planck
Paul Langevin — Walther Nernst
Paul Ehrenfest

$4.75

PHILOSOPHICAL LIBRARY
Publishers
15 East 40th St., Dept. 436, New York 16, N. Y.
(Expedite shipment by enclosing remittance with order.)

the advantage is yours . . with

PHYSICS *today*

A monthly magazine written especially for the reader outside the field being discussed, PHYSICS TODAY can keep you abreast of current happenings, trends, and problems in physics. Its feature articles, book reviews, news and views are presented in non-mathematical language with emphasis on generalization and principle, not on disparate detail. The American Institute of Physics, publishers of eight technical journals, began this post-war venture in science journalism expressly to let one kind of physicist know what another kind of physicist is doing, to let any scientist know what physicists are doing, and to provide old students (with a frustrated interest in current happenings) a new insight into physics, today. The cost is only $4.00 per year and we will be happy to include you on our subscription list if you would write your name and address below and mail this coupon and a remittance to:

PHYSICS TODAY • 57 East 55th Street, New York 22, N.Y.

Name_____
Address_____
City_____ State_____

A New SPITZ PLANETARIUM

is now in operation at:

UNIVERSITY OF
THE PHILIPPINES
Quezon City, P. I.

SCIENCE ASSOCIATES
401 N. Broad St. Phila. 8, Pa.

rived at by a painstaking logical process of elimination of alternative hypotheses for the reconciliation of the theory with the observations. The result, as we now know, heralded the advent of the quantum theory which, together with the theory of relativity, was to influence profoundly the physical thought in the first half of our century.

There exists sufficient evidence to prove that Planck was indeed aware of the epoch-making nature of his discovery; but it is equally evident (and his present autobiography bears it out anew) that he was not at all attracted by the prospect of following up its consequences. Instead, he deliberately directed his efforts toward a reconciliation of his new law with the principles of physics which he absorbed deeply in his youth. "My futile attempts to fit the elementary quantum of action somehow into the classical theory," wrote Planck almost half a century after his great discovery, "continued for a number of years, and they cost me a great deal of effort. Many of my colleagues saw in this something bordering on a tragedy. But I feel differently about it. For the thorough enlightenment I thus received was all the more valuable. I know now for a fact," he confesses, "that the elementary quantum of action played a far more significant part in physics than I had originally been inclined to suspect." As it happened, however, it was left to others to explore the avenues opened up by Planck's work—a task in which several of his own students took a prominent part.

Max Planck died in 1947, after a life of almost fourscore and 10 years, a life resembling a Greek tragedy and which brought him recognition, honors, disillusionment, family misfortunes, and the final disaster. Having outlived most of his contemporaries, he passed away as a monument of bygone days, leaving behind him a world totally different from the one in which he grew up, a world which his logical and well-ordered mind could no longer easily comprehend. An eloquent and noble tribute, delivered by Max von Laue as the funeral oration, prefaces this little but valuable volume, which should not be missing in the library of anyone interested in the history of philosophy of science.

ZDENEK KOPAL
Massachusetts Institute of Technology

Making Your Own Telescope **The Nature of Cosmic Rays**
Atlas of the Heavens **Sky and Telescope**

Sky Publications

Mappa Coelestis Nova **Splendors of the Sky**
Relativity and Its Astronomical Implications **Moon Sets**

MAKING YOUR OWN TELESCOPE, by Allyn J. Thompson, tells the complete story of how to make and mount a 6-inch reflecting telescope, at very low total cost. Excellent for use by telescope making groups. 211 pages, 104 illustrations. **$3.50**; foreign postage 40 cents

THE NATURE OF COSMIC RAYS, by W. F. G. Swann, gives a review of the fundamental physical and atomic principles involved in the study of this most powerful of all cosmic energies. 32 pages. **50 cents**

ATLAS OF THE HEAVENS, by Antonin Becvar and associates at the Skalnate Pleso Observatory. Sixteen charts cover the entire sky to magnitude 7.75, including doubles, multiples, variables, novae; galactic star clusters, globulars, and planetaries; 1950 co-ordinates. Each chart area is 15½ by 23½ inches. **$5.00**

SKY AND TELESCOPE may be sent as a gift; if requested, a donor's card is sent to the recipient of each gift subscription.

MAPPA COELESTIS NOVA, by Josef Klepesta, is a large wall chart, colorful as well as informative. The northern sky to −45° is shown on a polar projection, and each star is colored according to its spectral class. The chart makes a fine transparency, 28 inches square. **$3.50**

SPLENDORS OF THE SKY is a bargain in astronomical photographs, with explanatory captions, now in its third printing for a total of 36,000 copies in eight years. 36 pages, each 8½ x 11½ inches. **35 cents**, plus 5 cents postage

RELATIVITY AND ITS ASTRONOMICAL IMPLICATIONS, by Philipp Frank, is an outstanding explanation of the general theory of relativity, in language suitable for the layman. 24 pages. **50 cents**

MOON SETS are 18 full-sized plates, nine for the first-quarter moon and nine for the last quarter, from Lick Observatory negatives. Each plate is on a sheet of heavy stock 12 by 18 inches, and there are key charts for named lunar features. **$2.00**

All prices are postpaid except as otherwise noted. Order from your favorite bookstore, from the Adler, Buhl, Fels, Hayden, or Morehead Planetarium (see Planetarium Notes for addresses), or write us directly. Payment should accompany all mail orders.

SKY PUBLISHING CORPORATION
HARVARD COLLEGE OBSERVATORY, CAMBRIDGE 38, MASS.

LETTERS

(Continued from page 167)

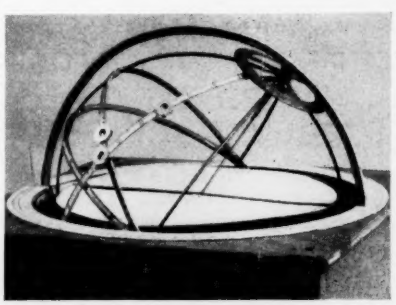
Imagine Alpha and Beta Ursae Majoris to form the hour hand of a 12-hour clock in the sky, centered on Polaris, to calculate the time of night as follows:

Hours elapsed since noon equals 16½ minus twice the sum of the clock time of the Pointers plus the months and portions elapsed. As this gives local time, a correction is needed for four time-minutes per degree distance of the observer from the standard time meridian of his area (add if west, subtract if east). Thus anyone strolling on a clear night can readily keep a check on time and direction.

CHARLES D. GRIMWADE
Capella, Dairyfields
Trentham, Stoke-on-Trent
England

Sir:

The accompanying photograph shows an armillary sphere I made in 1945, with what may be an unusual feature — the floating horizon. The device was designed to introduce to some boys the movements of the sun, moon, and planets as related to each other and the horizon, and as



affected by change of latitude. The horizon is swung from the polar axis. The half circle, with declinations north and south of the equator marked on it, pivots around the polar axis, and acts as an adjustable hour circle. Studs can be attached to it to mark the position of sun, moon, planet, or a star at any assigned time.

The principal circles of the armillary sphere are nine inches in diameter.

H. H. HAMMOND
26 Southdean Gardens
Wimbledon Park Road
London S.W. 19, England

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

A Springfield Mounting from War Surplus

MANY an amateur astronomer has the dream of building or buying a Springfield type of telescope mounting, one which will allow him to sit in a comfortable position, looking in one direction while the telescope swings around to find and follow any sky object he chooses. There is a very good reason that such dreams are seldom realized: expense. Worm gears and castings cost a lot, unless you own a foundry or a machine shop.

However, this type of mounting can be made very cheaply and fairly easily by using two panoramic gunsight telescopes which were being sold in 1948 by war surplus companies for $5.00 or $7.95, depending upon whether they were new or reconditioned. I used No. M12-A-3, although there are other sizes and types. These periscopes, for that is what they are, are beautifully constructed, and they contain all the glass parts necessary for a fine reflecting telescope except the mirror itself.

The panoramic gunsights have a splendid eyepiece, with a power I estimate to be about 50 or 60 with my mirror. The eyepiece may be adjusted by turning it for fine focus. There is an objective lens about 20 millimeters in diameter screwed into the first elbow, giving a fixed focus power of 6x to the gunsight. This lens is easily removed, as it must be for use of the device with the telescope mirror.

Inside the worm-gear assembly is a revolving prism, which keeps the object in view constantly upright. I removed this on the theory that it wasn't needed and would cut down the light. Both flats are coated glass, and both are protected from dust by coated glass disks. The upper flat may be adjusted by using the small worm gear at the top; its obstruction to the path of the incoming rays is not severe at this magnification.

There is also a sighting scale reticle which is easily removed from the eyepiece.

The gunsights were purchased at the Consumers Surplus Store, 928 N. Plankinton Ave., Milwaukee. They should still be found in similar stores elsewhere.

My first mirror support consisted of two long thin tubes, but I found that an aluminum tube would be necessary because lights from a nearby apartment are very troublesome to an uncovered mirror, and there is more vibration in the simple tube design than I had anticipated. The illustration shows a close-up of the mounting, as originally made. The periscope head in the optical path is supported on a piece of ¾" plywood by a heavy tin tube. A hose clamp and a metal strap hold the

This mounting, by Fred P. Strother, is made up of parts from two war-surplus panoramic gunsights, which contain slow-motion controls.

WAR SURPLUS BARGAINS

Government's 7 X 50 Binoculars

Assemble Them Yourself! Complete Optics! Complete Metal Parts! Save More Than ½ Regular Cost!

METAL PARTS—Set includes all metal parts—completely finished — for assembly of 7 X 50 Binoculars. No machining required. Sturdy Binocular Carrying Case is optional with each set of Metal Parts.

Stock #342-Y. $39.40 Postpaid, plus **$4.80** for Case. **Total $44.20**

OPTICS–Set includes all Lenses and Prisms needed for assembling 7 X 50 Binoculars. These are in excellent condition — perfect or near-perfect — and have new low reflection coating.

Stock #5102-Y ..... $25.00 Postpaid

Note: These are fine quality standard American-made parts, not Japanese.

NOTICE! If you buy both Binocular Optics and Binocular Metal Parts, add 20% Federal Tax.

$1200.00 VALUE FOR $95.00

SCISSORS TELESCOPE — Gives 100 times greater stereoscopic power than the unaided eye. Binocular type. Big field of view. 12 power. Furnished complete with tripod, mount and case. Used by Army and Navy for long distance spotting, target observation, etc. Used but good condition. Shipped f.o.b. Camden, N. J. (Weight approx. 79 lbs.).
Stock #952-Y $95.00

CONDENSING LENSES — Seconds, but suitable for Enlargers and Spotlights.
Stock #1103-Y–29/32" dia. ½" F.L. $ .50 ea. p.p.
Stock #1086-Y–1-11/16" dia. 3" F.L. $ .25 ea. p.p.
Stock #1077-Y–2⅜" dia. 3" F.L. .. $1.00 ea. p.p.
Stock #1084-Y–2½" dia. 4" F.L. ... $1.00 ea. p.p.
Stock #1099-Y–4-7/16" dia. 6½" F.L. $1.20 ea. p.p.
Stock #1080-Y–5" dia. 7" F.L. .... $1.00 ea. p.p.
Stock #1019-Y–6" dia. 16" F.L. .... $2.00 ea. p.p.
Stock #1061-Y–6½" dia. 9" F.L. ... $2.50 ea. p.p.

MOUNTED TELESCOPE EYEPIECE — Kellner type. Excellent astronomical and other telescopes. War Surplus. Government cost about $18.00. Focal length 24 mm. Lens diameter 23 mm. Unusually wide field.
Stock #5189-Y ..... $3.25 Postpaid

ADAPTER MOUNT (not surplus)—2⅛" long with standard 1¼" O.D. for use on astronomical telescopes. Threaded so Stock #5189-Y screws into it. Black anodized.
Stock #5190-Y ..... $1.00 Postpaid

CROSSLINE RETICLE — Dia. 29 mm.
Stock #2036-Y ..... 50c Postpaid

PLASTIC HOBBYISTS!—Your chance to get a large, heavy piece of super optical quality Plexiglas, approx. 1¾" thick, 7½" long, 6⅛" wide . . . weight, 4 lbs. 5 ozs. Actually a U. S. Army Plexiglas Periscope containing at least $7.00 worth of Plexiglas. Carve it! Saw it! Mold it! Makes numerous plastic novelties.
Stock #725-Y ..... $3.00 each Postpaid
6 or more units ..... $2.75 each postpaid
12 or more units ..... $2.25 each postpaid

FIRST-SURFACE MIRRORS
Stock #539-Y—60 mm. x 80 mm. .. 75c Postpaid
Stock #558-Y—45 mm. x 74 mm. .. 50c Postpaid
Stock #547-Y—43 mm. x 140 mm. .. 50c Postpaid
Stock #534-Y—25 mm. x 29 mm. .. 25c Postpaid

TELESCOPE EYEPIECE—Consists of 2 Achromatic Lenses, F. L. 28 mm. in a metal mount.
Stock #5140-Y ..... $4.50 Postpaid

SIMPLE LENS KITS!—THE LENS CRAFTERS DELIGHT! Fun for adults! Fun for children! Kits include plainly written illustrated booklet showing how you can build lots of optical items. Use these lenses in photography for copying, ULTRA CLOSE-UP SHOTS, Microphotography, for "Dummy Camera," Kodachrome Viewer, Detachable Reflex View Finder for 35-mm. cameras, Stereoscopic Viewer, ground glass and enlarging focusing aids. And for dozens of other uses in experimental optics, building TELESCOPES, low power Microscopes, etc.
Stock #2-Y—10 lenses ..... $1.00 Postpaid
Stock #5-Y—45 lenses ..... $5.00 Postpaid
Stock #10-Y—80 lenses ..... $10.00 Postpaid

SLIDE PROJECTOR SETS—Consist of all unmounted lenses you need to make the following size projectors:
Stock #4038-Y — 2¼" x 2¼" ..... $3.35 Postpaid
Stock #4039-Y — 2½" x 3½" ..... $3.35 Postpaid
Stock #4035-Y — 35 mm. ..... $4.85 Postpaid

We Have Literally Millions of WAR SURPLUS LENSES AND PRISMS FOR SALE AT BARGAIN PRICES. Write for Catalog "Y"—FREE!

Order by Stock No. *Satisfaction Guaranteed*

EDMUND SALVAGE CO.
BARRINGTON, NEW JERSEY

WAR SURPLUS BARGAIN

OPTICS!

ACHROMATIC TELESCOPE OBJECTIVES — Perfect Magnesium Fluoride Coated and cemented Gov't. Surplus lenses made of finest Crown and Flint optical glass. They are fully corrected and have tremendous resolving power and can be readily used with ¼" F.L. eyepieces. Guaranteed well suited for Astronomical Telescopes, Spotting Scopes, etc. Gov't. cost approximately $100.00.

Diameter	Focal Length	Each
54 mm (2⅛")	600 mm (23½").....	$12.50
76 mm (3")	381 mm (15").....	21.00
81 mm (3 3/16")	622 mm (24½").....	22.50
83 mm (3¼")	876 mm (34½").....	28.00
83 mm (3¼")	1016 mm (40").....	30.00

LENS CLEANING TISSUE—Here is a wonderful Gov't. Surplus buy of Lens Paper which was made to the highest Gov't. standards and specifications. 500 sheets size 7½" x 11". $1.00

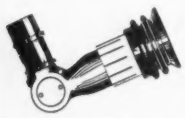
"GIANT" wide angle eyepiece finest ever made; gives flat field. Mounted in focusing cell, 2" clear aperture, 1½" E.F.L. 3 Achromatic lenses. Use also as Kodachrome Viewer; magnifies SEVEN times.

$125.00 Value **$12.50**

Mounted eyepiece has 2 perfect magnesium - fluoride coated achromatic lenses 29 mm in dia. Designed in order to give good eye relief, 1¼" E.F.L. (8X). Cell fits 1¼" tube. **$4.50**

SYMMETRICAL EYEPIECE LENS SET — These sets consist of two Magnesium Fluoride coated and cemented achromats, exact Gov't. spacing. Diagram. Gives wide flat field.

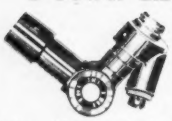
½" E.F.L. (20X) Lens Set—13 mm Dia. $4.50
⅝" E.F.L. (13X) Lens Set—18 mm Dia. 3.50



3x ELBOW TELESCOPE — Makes a nice low priced finder. Brand new; has 1" Achromatic Objective. Amici Prism Erecting System. 1⅜" Achromatic Eye and Field Lens. Small, compact, light weight, 2 lbs. Gov't. Cost $200.

Plain Optics **$6.50** Coated Optics **$10.50**

8 Power Elbow Telescope



Tremendous Wide Angle Eyepiece, apparent field of view 70°. Objective 1⅛" Diameter. Amici Erecting System. Brass construction, weight 28 oz. Small, compact, 1¾" x 4¾" x 4½". Has graduated crossline reticle with lamp housing to illuminate reticle. The Telescope contains a short focal length eyepiece, E.F.L. .602", which has 5 lenses.

ARMY USED **$18.50**
BRAND NEW **$27.50**

FIRST SURFACE MIRRORS
Manufacturer's contract cancelled. Perfect, have protective coating, will not scratch as easily as ordinary first surface mirrors. Used in precision instruments, projectors, telescopes, view finders, reflex cameras, etc.

12"X15" ¼" thick	$8.75
8"X10" ¼" thick	4.25
4"X 4" ⅛" thick	1.25
1¼"X1½" 1/16" thick	.25

"FREE CATALOGUE"
Sensational Optical Bargains
Send for it TODAY

WE PAY THE POSTAGE

A. JAEGERS 93-08S 95 AVE. OZONE PARK 16, N. Y.

eyepiece and prism assembly to a piece of ½" plexiglas turned to a 6" disk, which forms a setting circle for hour angle.

Two 4" floor flanges are used, one under the plywood and the other under the plexiglas disk, in each case reamed and threaded to fit on the worm drive shaft of the central part of each gunsight. My hand is turning the knob that controls hour angle. Attachment to the tripod mounting is by simple pipe fittings.

I have written a detailed description of the building of my mounting, but it is too voluminous to interest anyone who is not actually working on a similar project.

FRED P. STROTHER
1813 E. Jarvis St.
Milwaukee 11, Wis.

THE SOLAR FILTER PROBLEM

FREQUENTLY the writer has been called upon to replace dense filter caps for use on solar oculars. This indicates that in many cases serious optical damage to the observer has been averted by a small margin. We must be making a mistake in our methods of viewing the sun if such a concentration of heat is permitted to come so close to the observer's eye.

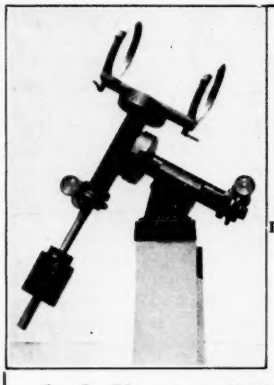
In my own observing of the sun I have always used a Herschel wedge ocular holder, with a dense neutral filter on the eyepiece and a diaphragm over the objective or mirror. Sometimes the filter was too dense for the particular observing conditions encountered, and at other times not nearly dense enough.

Here at Valley View Observatory we have tried using a variable density filter of polaroid disks encased in thin glass wafers. This proved impractical because the eyepoint on many oculars is too close to permit the insertion of this comparatively bulky "sandwich" of glass and polaroid. Larger inexpensive polaroid disks ahead of the objective eliminated the eyepiece filter, certainly, but caused overlapping images and ruined definition.

A satisfactory method of decreasing the sun's brightness was found by using a welder's filter lens 2" x 4" in size, obtainable at any dealer handling welder's supplies. This lens is really a piece of filter glass, of neutral shade, ⅛" or less in thickness, which fits into the electric welder's hood. Several degrees of density are available, those having numbers 6, 8, 10, and 12 being best for solar work. Lighter densities are indicated by the lower numerals. The filters cost about a dollar each, but are well worth it for our purpose, since they are "optically plano by precision surface grinding and polishing. **That means the surfaces are true and parallel."** The quotation (with underline) is taken from the manufacturer's envelope.

These filters can be used by making a diaphragm to cover the objective or mirror, supporting them by means of slots or guides in this disk. They should be easily removable. The diaphragm should have a hole slightly less than 2" in diameter if round, and slightly less than 2" by 4" if rectangular. To determine which filter should be used at a particular time, hold the densest of them up about a foot

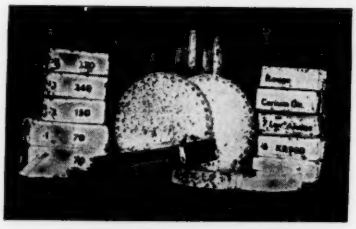
Coated Astronomical Objective
3⅛ inch by 50-inch focal length, air spaced, in black anodized duraluminum barrel.
• Individually hand corrected and figured •
Price $62.00
Dioptric Engineering Laboratories
47 West 56th St., New York 19, N. Y.



Amateur Telescope Makers Supplies
Ramsden Eyepieces
Combination Eyepiece and Prism Holders
Mirror Cells
Finders
Equatorial Mountings
Prisms
Send for a price list

C. C. Young **25 Richard Road East Hartford 8, Conn.**

New Low Prices on PYREX Reflecting Telescope Kits



Two circle dials with every Pyrex Kit.

The most complete kits on the market. In addition to the usual supply of abrasives, rouge, etc., you get the new, fast-polishing cerium oxide to save hours of work. You can get a brass diagonal holder (spider) for only $1.00 additional if ordered with a telescope kit. Prices quoted below are for a Genuine Pyrex telescope blank and a plate glass tool.

PYREX MIRROR KITS

4"	$ 5.25	6"	$ 6.75
8"	9.75	10"	16.75
12½"	31.75	16"	65.00

4" to 16" PYREX CARRIED IN STOCK

PLATE GLASS KITS

6" x ¼"	$4.75	6" x 1"	$ 5.25
8" x 1"	7.25	9¼" x 1½"	12.50

Postage Paid to 1st and 2nd postal zones from N. Y. Add 5% 3rd and 4th zones, 10% 5th and 6th zones. Add 15% 7th and 8th zones.
Parabolic pyrex mirrors made to order.
Send for free catalog of optical supplies.
DAVID WILLIAM WOLF
334 Montgomery St. Brooklyn 25, N. Y.

~~ALUMINIZING~~

HARD BER-AL COATING

Our exclusive high-reflectivity BER-AL coatings are free from chromium and they are not overcoated with fluorides or quartz. They can be removed easily, when desired, without harm to the glass surface below. Prices for BER-AL coatings, f.o.b. Chicago, are: $2.50 for 6" diameter mirrors, $3.50 for 8", $5.00 for 10", and $8.00 for 12½". Larger sizes up to 24" diameter on request.

LEROY M. E. CLAUSING
4544 N. Western Ave. Chicago 25, Ill.

SKY-SCOPE

The new and improved 3½-inch Astronomical Telescope that amateurs everywhere are talking about.

Completely Assembled — $25.00
Equatorially Mounted, 60 Power
¼-wave Aluminized Mirror
Ramsden Type Ocular
100x & 35x Supp. Eyepieces, ea. $5.00

We invite your attention to our free brochure describing in a straightforward manner the instrument's amazing performance.

THE SKYSCOPE CO., INC.
475-s Fifth Avenue, New York 17, N. Y.

Now! Saturn 3 Inch
PORTABLE REFRACTORS
Only $199.00

For the first time an instrument capable of serious astronomical research is available for less than $200.00! The Saturn 3 Inch Portable Refractors are precision made by the West's largest makers of observatory instruments; objective lenses are highest grade precision ground, achromatic f-15 crown and flint glass, all moving parts are precision machined.

Although the Saturn 3 Inch Refractor has a 45 inch focal length, the instrument is easily portable, weighing less than thirty pounds, including tripod.

Saturn 4 Inch Portable Refractors from $345.00; larger instruments manufactured to order.

Write for literature giving full information on the Saturn Refractors.

Tinsley
2530 Grove Street
Berkeley, California

from the eye, and look at the sun. If you see a sharply outlined solar disk, the filter is suitable; use the filter of least density that will give this image.

Even with one of these filters over the objective, it is still good policy to use a Herschel wedge in place of the usual right-angle ocular holder on a refractor. On a reflector one should use a filter of slightly greater density than the above rule-of-thumb would call for, to compensate for the lack of the Herschel wedge.

With this arrangement on a 3-inch refractor stopped down to two inches, the writer observed the tremendously large sunspot groups which transited the sun's surface recently, estimating their length at nearly 100,000 miles. These spot groups showed a wealth of detail in the higher powers, and it was a pleasure to view them leisurely, calm and serene in the knowledge that I would not have to be ready at any instant to pull my head away from the eyepiece should I hear the click of shattering glass due to accumulated heat in the filter cap.

If anyone has difficulty in obtaining welder's filters or does not have a nearby source of supply, I shall be glad to furnish the names of dealers in this vicinity.

LEO J. SCANLON
106 Van Buren St.
Pittsburgh 14, Pa.

J. G. Goodsell's telescope is mounted on a cement pedestal.

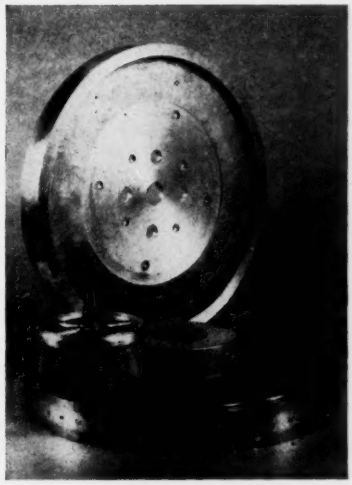
A BACK-YARD REFLECTOR

One of the enclosed pictures shows my 6-inch reflector mounted in my back yard on a cement pedestal. Its newest attachment is an aluminum pedestal which screws into either side of the saddle carrying the telescope tube. The picture shows my Ciro-flex camera screwed into the saddle. I do not have a clock movement, but hope to some time.

The other picture [not reproduced] shows a very handy wooden case with slots for holding four eyepieces, a pencil flashlight, a special screwdriver, an oilcan, and other supplies. The box is finely made and was sent to me, containing a beautiful Buddha, from Hiroshima, where one of my former Japanese pupils is a teacher.

J. G. GOODSELL
1114 Windsor Place
South Pasadena, Calif.

13-INCH SETTING CIRCLES



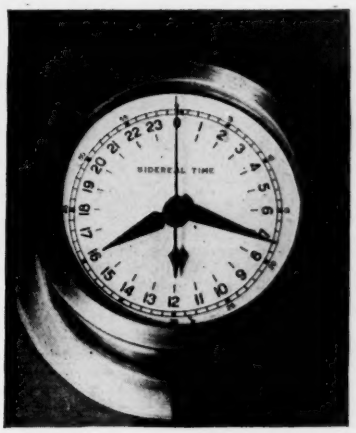
OBSERVERS — EQUIP YOUR MOUNTINGS WITH CO-ORDINATE CIRCLES
$35.00 a pair

With these large, finely made circles carrying 1440 divisions each, you can instantly find stars and nebulae that are invisible to the naked eye and also identify them from the catalog.

1. Set declination of star first. 2. Set the time circle (upper graduations) to the right ascension of the star with the telescope stationary. 3. Now move the telescope carrying the time circle until the lower graduations read your local sidereal time. The star will be centered in your low-power eyepiece. Free instructions and sidereal-time formula.

To identify a star: While it is in the telescope, move the time circle to sidereal time and take readings of the R. A. and Dec. Then compare with the star catalog.

ELECTRIC SIDEREAL CLOCK



Sidereal time is required for the positive location and identification of celestial bodies visible or invisible to the naked eye.

This clock has gears that give a computed rating of less than six minutes slow in a century. Cast aluminum base, bronze front bezel, 4" minute circle, metal dial. Hands may be set from the front or back. 110 volts 60-cycle or 50-cycle on request. Good for all climates. **$36.00.**

Observers wishing to convert their standard clocks to sidereal may do so under our free instruction. The cost of gear changes is about $5.00. 24-hour dials may be had directly from John Stofan, 332 Herrick Ave., Teaneck, N. J., at a cost of $1.00 each.

Haines Scientific Instruments
Box 171, Englewood, New Jersey
Telephone: ENglewood 3-3441-J

something new for stargazing . . .

STARSCOPE

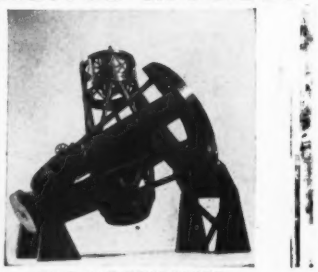
Through the medium of optical illusion, star charts are made to appear as though actually projected on the night sky.

Our descriptive circular gives full details.

STARSCOPE with battery, 30 charts, and instructions, postpaid $2.98

POLARIS D. AND M. COMPANY
88 Howard St. Linden, Missouri

SCIENCE MODELS



THE 200" TELESCOPE
⅛" SCALE DISPLAY MODEL
Complete construction kit $2.50 postpaid
S. E. HUBBARD — 1463 N. LEAVITT ST.
DEPT. B CHICAGO 22, ILL.

THE BRITISH INTERPLANETARY SOCIETY
(Limited by Guarantee)
157 Friary Road, London, S. E. 15

Membership is open to all interested in astronautics and rocket development. The Society issues a bi-monthly **Journal** and a yearly **Annual Report and List of Members.** Lectures, film displays, and visits to observatories and scientific laboratories are also arranged.

Particulars of membership and fellowship and specimen copies of the Society's publications will be sent free of charge to interested persons.

Address all communications to the Secretary at the address shown above.

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

VISUAL OBSERVING PROGRAMS FOR AMATEURS — II

Instruments — continued

THE EYE. As Lord Kelvin once remarked, the human eye is a very imperfect instrument. Let us take heart, however. What has photographic film got that the eye has not? Its principal advantages are an infallible memory and a cumulative chemical effect (time exposure). However, if film is exposed for, say, 10th-magnitude stars, those of the 8th and brighter are overexposed and those of the 12th and below are underexposed, so that outside this range of four magnitudes film is relatively inaccurate, whereas the eye can work over tremendous differences in brightness. Like the eye, film is not equally sensitive to light of all colors. Usually, it "sees" blue best.

We can be just as proud of eye observations as of photographic records, but we should note some of the idiosyncrasies of the eye to be aware of the limitations of our fundamental observing instrument.

For our purposes, the eye can be considered as a telescope of about 0.67-inch focal length with varying aperture, usually assumed to be 0.2 to 0.3 inch in the dark. Its magnifying power is 1. It is said to be able to see 6th-magnitude stars, but only twice in his life has the writer had good enough seeing to do this. In New York and other large cities my limit is 3, in smaller cities 4, and it is 5 for me in country communities. Others may have fainter limits than these. The field of view of a single eye without rolling it around is some 150°.

Different colors, such as green, red, blue, and even white, are more distinctly seen by certain parts of the retina than by its other areas. Authorities seem to differ, but the central six or eight degrees of field of the eye (the **macula** or yellow spot) is said to be less sensitive to green and blue than the surrounding retina. In an area just outside of the yellow spot green is seen best; outside of that, red; outside of that, blue; and the outer zone of the field of vision perceives objects only in gray tones. This color inaccuracy may very well affect the impressions of the colors one sees on the moon and planets, and probably it does affect estimates of the relative brightness of two stars if they are of markedly different colors, such as red and white.

The eye is not achromatic, that is, it does not bring all colors to an equally sharp focus; witness the common phenomenon that blue Christmas-tree lights appear blurred.

Some recent tests by the writer indicate that with my unaided eye I can see a line which appears only 2.95 seconds of arc wide, but that I cannot separate an artificial double star until its components are 262 seconds apart. This is a ratio of 1 to 89. The reason for such greater acuity for narrow lines is not known, but it is suspected to be related to the fact that the eyeballs are continually vibrating back and forward about 60 to 75 times a second.

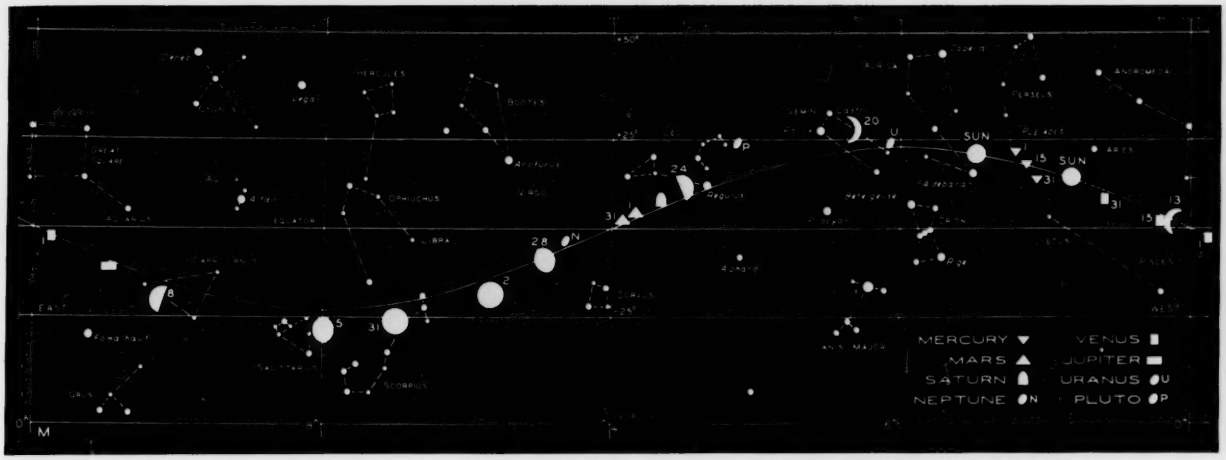
The eye is most aware of fine detail in the sensitive center of the retina **(fovea centralis)**. It is perhaps more able to detect faint stars at a few degrees from the center of vision, which is why an observer employs "averted vision" to pick up faint objects. An eye may suffer from nearsightedness **(myopia)**, farsightedness **(hypermetropia)**, and lack of focusing ability, chiefly for close objects **(presbyopia)**. Changing the telescope focus will correct spherical troubles such as these very exactly, which is why observers with imperfect vision can do relatively better work at the telescope than with the naked eye. If an eye suffers from considerable astigmatism, which is a cylindrical error, glasses must be worn at the telescope, at least for solar, lunar, and planetary work.

Some four per cent of men are insensitive to red and green (dichromatic color blindness), which might affect their estimates of the brightness of red variable stars, as compared with the results of other observers. But it might actually make their estimates more consistent, for normal eyes have trouble estimating red stars. This is because a bright red star seems to stimulate the normal retina so that the star appears to grow in brightness for a few seconds after one first looks at it. This is the Purkinje effect, though the phenomenon is usually stated in different terms than these.

Naked-eye Observations. Our fundamental observing instrument is used first and foremost for the study of the constellations and the brighter stars in each. For amateur astronomers this knowledge is as important as knowing the locations of the countries of the world and their principal cities is to a traveler. The path of a meteor and the areas of the sky occupied by aurorae and the zodiacal light can best be delineated by using known stars as reference points. If we are going to search the entire dome of the sky or a special area for bright novae, we must know in advance what stars of the 1st, 2nd, and perhaps 3rd magnitudes are regularly visible, checking our recollection against a star map if memory proves fallible.

If one is going to time a minimum of Algol, it is desirable to know where to find the constellation Perseus, and Algol itself should be easily identified from one's prior acquaintance with the bright stars of Perseus. Planetary observation is facilitated, of course, if we know all the 1st-magnitude stars of the zodiac and the principal constellations there—an interloper is then easily spotted and is known to be a planet. The five bright planets should be well known to the amateur observer, and he should be able to keep track of them as they move around the sky.

To become really familiar with the constellations requires only a few minutes under the stars once a week, for an entire year. An alternative to this easy but lengthy procedure is to observe for an entire night or two, during which about three-fourths of the sky available in temperate latitudes may be seen. A few



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

months later, when the sun has moved out of the way, the remaining portion of the sky may be studied in the morning hours. For the serious-minded amateur this is time well spent.

The eye, despite its limitations, is the best instrument available for seeing aurorae and the zodiacal light; for nova hunting or group meteor counting; and for making ordinary estimates of the magnitudes of bright variable stars, such as Nova Herculis 1934, Nova Puppis 1942, Gamma Cassiopeiae, Betelgeuse, Delta Cephei, and Mira (Omicron Ceti) near maximum. For accurate estimates of Algol and the brightness of comets, out-of-focus images in binoculars are more exact, as will be described in our next article.

DAVID W. ROSEBRUGH

DEEP-SKY WONDERS

AMATEURS who plumb interstellar depths with even small telescopes never fail to exclaim over the lustrous beauty of these three globular clusters.

M53, NGC 5024, $13^h\ 10^m.5$, $+18°\ 26'$, in Coma Berenices, is a brilliant globular blazing in the center. Visually, long attention will reveal irregular chains of small stars running out from the edges into the neighboring faint star fields. Three minutes of arc in diameter, M53 stands magnification well; photographically, its diameter is found to be 14'.4, and its integrated magnitude 8.7.

M68, NGC 4590, $12^h\ 36^m.8$, $-26°\ 29'$, in Hydra, is of about the same apparent size as M53, about one magnitude fainter. Admiral Smyth speaks of it as "mottled," but this writer could see only a pale, almost even disk with no hint of resolution into stars. There is something about its pale gray luminosity that impels the sky watcher to return to it time after time.

NGC 5139, $13^h\ 23^m.8$, $-47°\ 3'$, is more familiar as the great Omega Centauri cluster, visible to the naked eye as a 5th-magnitude star. It is equally rewarding in binoculars, small telescopes, and large reflectors. The writer has seen it well as far north as Tuscaloosa, Ala., and those amateurs in our southern states who have not yet chanced on it should make it a must on their next evening's program. Were it in the northern skies it would be as renowned an object as the great Orion nebula, for it is fully as beautiful.

WALTER SCOTT HOUSTON

Mercury will be poorly situated for observing in May. Opening the month as an evening object, the planet sets 1½ hours after the sun, but is +1.4 magnitude. Inferior conjunction takes place on May 14th, Mercury moving into the morning sky.

Venus continues as a morning star, rising 1½ hours before the sun. In the middle of the month, the planet will be 65 per cent illuminated and its disk will have decreased to 18″ in apparent diameter.

Mars crosses the meridian shortly after sunset, located halfway from Regulus to Spica. Retrograde motion ends May 5th, and eastward motion is resumed. The ruddy planet will fade from magnitude −0.4 to +0.2 during May, with a decrease from 12″.3 to 9″.8 in the apparent diameter of its disk.

Jupiter reaches western quadrature on May 27th, rising four hours before the sun. Its stellar brightness has increased to −1.9; the planet is located in Aquarius, where it adds considerable splendor to that rather drab part of the sky.

Saturn, in eastern Leo, ends its retrograde motion on May 16th. It is of magnitude 1.0, exactly the 1st-magnitude standard. A close conjunction with the moon occurs on May 25th, at 14:32 UT, Saturn 7′ north geocentrically.

The ring system will reach its maximum inclination for the year about May 13th, 4°.8 open. The major axis will be 42″ long, the minor about 3″.5. The southern side of the rings is visible, but it will grow narrower until September 14th. Then the rings will be edge on, but Saturn will be invisible close to the sun.

Uranus is not favorably placed for observation, because of its proximity to the sun in the sky.

Neptune will be on the meridian about 9 p.m., local time, located in central Virgo. The planet is in retrograde motion and of the 8th magnitude.

E. O.

PREDICTIONS OF BRIGHT ASTEROID POSITIONS

		h	m	°	′
No. 11	**Parthenope**			Mag. 9.0	
May	9	16	59.6	−15	56
	19	16	52.2	−15	40
	29	16	43.1	−15	28
June	8	16	33.3	−15	21
	18	16	24.0	−15	21
	28	16	16.4	−15	30
No. 1	**Ceres**			Mag. 7.5	
May	9	17	8.8	−19	13
	19	17	1.3	−19	31
	29	16	52.2	−19	50
June	8	16	42.6	−20	09
	18	16	33.3	−20	28
	28	16	25.5	−20	48
No. 10	**Hygiea**			Mag. 9.0	
May	9	17	22.7	−26	23
	19	17	16.9	−26	13
	29	17	9.3	−25	59
June	8	17	0.9	−25	37
	18	16	52.5	−25	12
	28	16	45.1	−24	43

The above are predicted positions in right ascension and declination for the epoch 1950.0, for 0^h Universal time. The magnitude is that expected at opposition. In each case the motion of the asteroid is retrograde.

VARIABLE STAR MAXIMA

May 3, R Canum Venaticorum, 7.7, 134440; 8, RR Scorpii, 6.0, 165030a; 14, R Lyncis, 7.9, 065355; 14, S Virginis, 7.1, 132706; 14, RR Sagittarii, 6.6, 194929; 18, T Cassiopeiae, 7.8, 001755; 19, X Monocerotis, 7.6, 065208; 22, R Leporis, 6.7, 045514. June 1, U Ceti, 7.5, 022813; 1, Z Puppis, 7.9, 072820b.

These predictions of variable star maxima are by Leon Campbell, honorary recorder of the AAVSO. Only stars are included whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

CORRECTION

George A. Davis, Jr., of Buffalo, N. Y., points out that the magnitude of NGC 628 published on page 102 of the March issue is incorrect, and should have read magnitude 11.2.

BARLOW LENS Send stamped return long envelope with 6c postage (not air mail) for free 9-page truly astounding educational information as to how a Barlow can greatly improve your telescope images and magnifications.
F. L. GOODWIN
345 W. Belden Ave., Chicago 14, Ill.

EYEPIECE AND OBJECTIVE BARGAINS
Send for Free List
F. W. BALLANTYNE
P. O. Box 382
Point Pleasant New York

RAMSDEN EYEPIECES
$4.20 each
Professional Make — Excellent Optics
Brass mounts, 1¼" dia., easily cleaned, 1", ½", ¼" equivalent focal lengths
Low prices on 5" and 6" achromat blanks. Send for information.
DE PALMA OPTICAL CO.
13031 Oxnard Blvd., Van Nuys, Calif.

EVERYTHING FOR THE AMATEUR
TELESCOPE MAKER KITS 6"—$5.50 up; Pyrex, 6" ... $7.50 up. Other sizes in proportion.
ALUMINIZING
Superior Reflecting Surface, Fine Finish. Will not Peel or Blister. Low Prices.
Mirrors Tested Free | Prisms Eyepieces Accessories | Send for Free Catalog
MONEY BACK GUARANTEE
Precision Optical Supply Co.
1001 E. 163rd St., New York 59, N. Y.

WE REPAIR
★ *Microscopes* ★ *Telescopes*
★ *Field Glasses* ★ *Binoculars*
WE BUY, SELL, EXCHANGE OPTICAL AND SCIENTIFIC INSTRUMENTS
WAELDIN 10 Maiden Lane New York City BEekman 3-5393

AN ALBUM OF CELESTIAL PHOTOGRAPHS
By A. L. Bedell
A selection of astronomical pictures by the world's large telescopes.
65 pictures with separate captions, bound in a heavy paper cover, originally priced at $1.50, now closing out at $1.25 postpaid.
SKY PUBLISHING CORPORATION
Cambridge 38, Massachusetts

"BLUE" MOONS IN MAY

In answer to an inquiry from Sofia Valdes Ynfante y Ortiz, of Marianao, Havana, Cuba, who asks when in May in the future there will be two full moons, and in what previous year and month have two full moons most recently occurred, H. Porter Trefethen, of Winthrop, Me., writes:

In 1969 the month of May will have two full moons.

In 1947 August full moons occurred on 1 Friday 8:50 p.m. EST, and on 31 Sunday 11:34 a.m. EST. Since the average length of the synodic month is 29.5306 days, two full moons in the same month is not an extraordinarily rare occurrence, and for any particular month they usually come at intervals of 19 years, the Metonic cycle. According to the **Maine Farmers' Almanac**, May full moons have occurred on the following dates (all times EST):

1950 May 2 Tuesday 0:19 a.m. and 31 Wednesday 7:43 a.m.

1931 May 2 Saturday 0:14 a.m. and 31 Sunday 9:33 a.m.

1912 May 1 Wednesday 5:40 a.m. and 30 Friday 6:51 p.m.

1893 April 1 Saturday 2:39 a.m. and 30 Sunday 6:44 p.m. and May 30 Tuesday 10:43 a.m. (This irregularity for 1893 comes about probably because there were only four intervening leap years instead of the usual five).

1874 May 1 Friday 11:30 a.m. and 31 Sunday 2:07 a.m.

1855 May 1 Tuesday 11:24 p.m. and 31 Thursday 10:09 a.m.

1836 May 1 Sunday 3:19 a.m. and 30 Monday 11:20 a.m.

MOON PHASES AND DISTANCE

Full moon	May	2, 5:19
Last quarter	May	8, 22:32
New moon	May	17, 0:54
First quarter	May	24, 21:28
Full moon	May	31, 12:43
Last quarter	June	7, 11:35

	May	Distance	Diameter
Perigee	2d 7h	221,800 miles	33′ 28″
Apogee	15d 22h	252,600 miles	29′ 24″
Perigee	30d 16h	222,600 miles	33′ 21″
	June		
Apogee	12d 6h	252,200 miles	29′ 26″

Note: Perigee coincides with full moon twice in May. The brightness of the moon is 25 per cent greater as compared with an apogee full moon.

MINIMA OF ALGOL

May 2, 6:27; 5, 3:16; 8, 0:05; 10, 20:54; 13, 17:43; 16, 14:32; 19, 11:21; 22, 8:10; 25, 4:58; 28, 1:47; 30, 22:36. June 2, 19:25; 5, 16:14.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See **Sky and Telescope**, Vol. VII, page 260, August, 1948, for further explanation.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

SKY-GAZERS EXCHANGE

Classified advertising costs 8 cents a word, including address; minimum charge $2.00 per ad. *Remittance must accompany order.* Insertion is guaranteed only on copy received by the first of the month preceding month of issue; otherwise, insertion will be made in next available issue. We cannot acknowledge classified ad orders. Write Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.

TELESCOPES and all accessories bought, sold, or exchanged. Valley View Observatory, 106 Van Buren St., Pittsburgh 14, Pa.

TELESCOPES FOR JUNIORS: All the parts (except lenses) to make an 8-power beginner's telescope as described in September, 1949, **Sky and Telescope.** Single kit $2.50; carton of 5 kits $10.00; carton of 10 kits $17.50; shipped postpaid. Eight construction charts and two instructor's manuals for club use, $1.00. Junior Astronomy Club, 2717 Euclid Ave., Cleveland 15, Ohio.

FOR SALE: Mounted 4", 5", and 6" refractor objectives of first quality. $60.00, $180.00, and $300.00. Correspondence invited. Earl C. Witherspoon, Sumter, S. C.

MIRRORS, hand-ground, polished and silvered; up to 12". Satisfaction guaranteed. 6" plate, $40.00; pyrex, $50.00. Write Ed C. Rizzo, Highland Hts., Ft. Thomas, Ky.

URANIUM ORE collection. Know what uranium ore looks like. 4 specimens $2.50 up to $15.00. Meteorites, genuine, $2.00 to $50.00. Collapsible tripod for refractor, $10.00. Astronomical Laboratory, 2846 Oakley Ave., Baltimore 15, Md.

FOR SALE: Books and magazines (including **Sky and Telescope** volumes) on astronomy and other subjects. Send postcard for free list. J. E. Brugh, 2827 McKelvey Rd., Pittsburgh 21, Pa.

BARLOW LENS: Send stamped return long envelope with 6c postage (not air mail) for free 9-page truly astounding educational information as to how a Barlow can greatly improve your telescope images and magnifications. F. L. Goodwin, 345 W. Belden Ave., Chicago 14, Ill.

HIGH POWER oculars little used come into their own when using a Metzger Glare Reduction Screen with astronomical telescopes. Simple to attach or remove. This processed screen diminishes glare around bright objects thus aiding detection of faint companion stars and better detail on planets. Shows beautiful spectrum pattern but leaves object in large dark area with crisp edges. A "must" for all refractors or reflectors. Give outside diameter of cell block or mirror tube. Price $1.00. Order now. Hal Metzger, Alfred Station, N. Y.

ZEISS 18 x 50 featherweight binoculars, central focus, with straps, case. Excellent condition. $175.00. H. Witman, Sinking Spring, Pa.

ASTRONOMICAL telescope mirrors made to your specifications unaluminized, 4¼", 6", 8" diameters. $20.00, $30.00, $70.00, respectively. Guaranteed to be of the highest optical quality. P. Klatt, 3107 Guilford St., Philadelphia 15, Pa.

FOR SALE: F/.9 ellipsoidal secondary mirrors for Johnsonian type telescopes, $200.00. Primary mirrors for above priced on request. 4½" to 12½" telescope mirrors made to order. All surfaces guaranteed optically perfect. Edwin Downey Funck, 2933 Boudinot, Cincinnati, Ohio.

WHILE spring cleaning we found a few copies of now out-of-print Spouse-McCallum chart of the northern visible hemisphere showing location of constellations, doubles, variables, clusters and nebulae in right ascension and declination. Three feet square on white paper. $2.50 postpaid. Tinsley Laboratories, Inc., 2526 Grove St., Berkeley 4, Calif.

ELECTRIC DRIVES: Effective July 1st the price of our standard model electric drive will be $65.00 F. O. B. Fellows Engineering Works, Middle Haddam, Conn.

ASTRONOMICAL BOOKS and star atlases of foreign authors. Orders taken. Please give title and publisher. Herbert A. Luft, 42-10 82nd St., Elmhurst, N. Y.

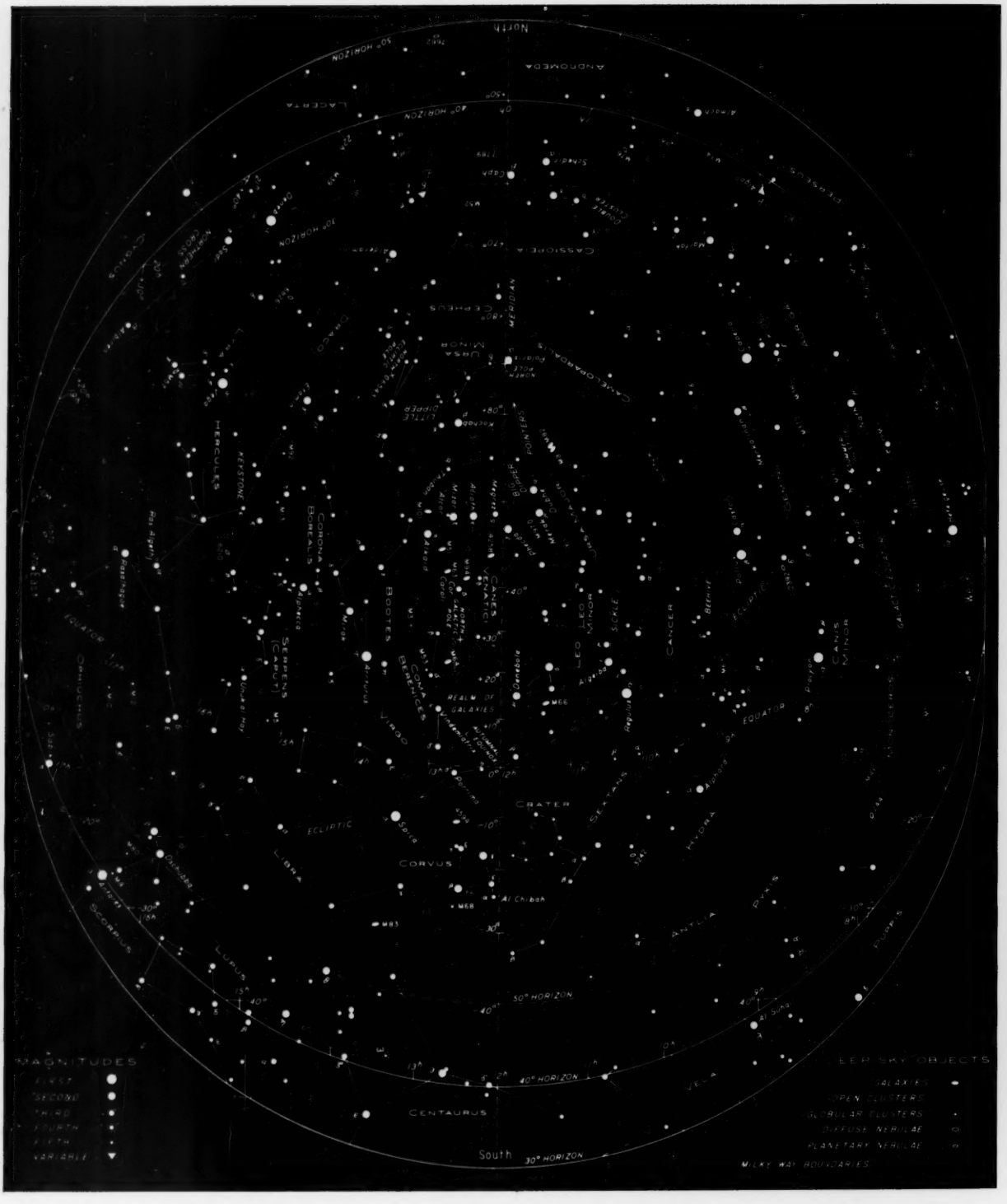
MIRRORS GROUND and polished, to your specifications. Workmanship and materials guaranteed. Submit specifications for prices. Don H. Murphy, 2421 N. High St., Columbus, Ohio.

BINOCULARS: Astra Paris 12x, like new, complete with pigskin case and straps; best offer over $40.00. C. E. Paxson, 2400 Sedgwick Ave., New York 63, N. Y.

HERE AND THERE WITH AMATEURS

*Members receive *Sky and Telescope* as a privilege of membership. †Member organizations of the Astronomical League.

State	*City*	*Organization*	*Time*	*Meeting Place*	*Communicate With*
ALABAMA	Gadsden	*Ala. A.A.*	7:30, 1st Thu.	Ala. Power Audit.	Brent L. Harrell, 1176*W* or 55
ARIZONA	Phoenix	**Phoenix Obs. Ass'n.*	8:00, 1st, 3rd Tue.	Phoenix College	Paul E. Griffin, 1708 S. 3rd St.
CALIFORNIA	Los Angeles	*L.A.A.S.*	**7:45, 2nd Tue.**	Griffith Obs.	H. L. Freeman, 853½ W. 57 St.
	Norwalk	*Excelsior Tel. Club*	7:00, Thu.	Excelsior Union H.S.	Geo. F. Joyner, 410 Sproul St.
	Oakland	**Eastbay A.S.*	8:00, 1st Sat.	Chabot Obs.	Miss A. Roemer, 1556 Everett, Alameda
	Palo Alto	**Peninsula A.S*	7:30, 1st Fri.	Community Center	Mrs. D. Rossiter, 922 Roble Ave., Menlo Pk.
	Sacramento	**Sac. Val. A.S.*	8:00, 1st Tue., bi-mon.	Sacramento College	Mrs. Helen Schopke, 3111 12th Ave. (17)
	San Diego	***Ast. Soc. of S.D.***	7:30, 1st Fri.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	*A.T.M. Ast. Club*	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	G. A. Sharpe, 4477 Muir, *Bayview* 3757
COLORADO	Denver	*Am. Tel. Cl. of Den.*	8:00, 2nd, 4th Mon.	Chamberlin Obs.	W. E. Johnson, 264 S. Gilpin St.
CONNECTICUT	New Haven	†*New Haven A.A.S.*	8:00, 4th Sat.	320 York St.	Mrs. Helen Velardi, 437 Wash., N'th Haven
	Norwalk	*Norwalk A.S.*	8:00, Last Fri.	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-5947
	Stamford	**Stam. Museum A.A.*	8:00, 3rd Fri.	Stamford Museum	Thomas J. Page, 52 Frank St.
DIST. COL.	Washington	†*Nat'l. Cap. Ast'mers*	8:00, 1st Sat.	Comm. Dept. Audit.	Janet Perkins, 2141 Eye St. NW (7), *Re* 7676
FLORIDA	Daytona Beach	*D. B. Stargazers*	8:00, Alt. Mon.	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
	Jacksonville	**J.A.A.C.*	8:00, 1st, 3rd Mon.	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
	Key West	†*Key West A.C.*	8:00, 1st Wed.	Private homes	W. M. Whitley, 1307 Div. St., 724-R
	Miami	*South'n Cross A.S.*	7:30, Every Fri.	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26 Rd.
GEORGIA	Atlanta	*Atlanta Ast'mers*	7:30, 2nd Fri.	Agnes Scott College	W. H. Close, 225 Forkner Dr., Decatur
ILLINOIS	Chicago	†**Burnham A.S.*	8:00, 2nd Tue.	Chi. Acad. of Sci.	Wm. Callum, 1435 Winona St.
	Geneva	**Fox Valley A.S.*	8:00, 1st Tue.	Geneva City Hall	Joseph Zoda, 501 S. 6th, St. Charles
	Moline	†**Popular A.C.*	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, 3201 Coaltown Rd.
INDIANA	Indianapolis	†*Indiana A.S.*	2:15, 1st Sun.	Riley Library	E. W. Johnson, 808 Peoples Bank Bldg.
KANSAS	Topeka	**Topeka A.A.S.*	7:30, 2nd Mon.	Topeka H.S.	Miss N. Utschen, 1607 Wayne Ave.
	Wichita	†**Wichita A.S.*	8:00, 1st Wed.	.....	Dollie Ratcliff, 801 Maple, 2-1822
KENTUCKY	Louisville	†*L'ville A.S.*	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 621 34th St.
	Owensboro	†**Owensboro A.C.*	8:00, 3rd Sat.	Public Library	Herman Batt, 1507 Hathaway St.
LOUISIANA	New Orleans	***A.S. of N.O.***	8:00, Last Wed.	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MAINE	Portland	†*A.S. of Maine*	8:00, 2nd Fri.	Private homes	H. Harris, 27 Victory Ave., S. Portland
MASSACHUSETTS	Cambridge	†**Bond A.C.*	8:15, 1st Thu.	Harvard Obs.	C. A. Federer, Jr., Harvard Observatory
	Cambridge	†**A.T.M.s of Boston*	8:00, 2nd Thu.	Harvard Obs.	J. Killion, 67 Roberts, Roslindale (31)
	Springfield	†**S'field Stars*	8:00, 2nd Wed.	Private homes	F. D. Korkosz, Mus. Nat. Hist., 2-4317
	Worcester	†**Aldrich A.S.*	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	Ralph A. Wright, 4 Mason St.
MICHIGAN	Ann Arbor	†*Ann Arbor A.A.A.*	7:30, 2nd Mon.	U. of Mich. Obs.	Stewart W. Taylor, 1106 Birk Ave.
	Battle Creek	†*B. C. A.A. Club*	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett St.
	Detroit	†**Detroit A.S.*	3:00, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Detroit	†**N.W. Detroit A.S.*	8:00, 1st Tue.	Redford H. S.	John W. Broxholm, 21412 Pickford
	Kalamazoo	†*Kalamazoo A.A.A.*	8:00, Sat.	Private homes	Mrs. G. Negrevski, 2218 Amherst, 31482
	Lansing	†**Lansing A.A.*	8:00, 1st, 3rd Wed.	Technical H. S.	Mrs. T. A. Louden, 940 Bensch St. (14)
	Pontiac	†**Pontiac A.A.A.*	8:00, 3rd Sun.	Cranbrook Inst.	Mrs. M. Chircop, 147 Prospect St., 21455
MINNESOTA	Duluth	†**Darling A.C.*	8:00, 1st, 3rd Fri.	Darling Obs.	Mrs. A. Lynch, 1911 Wisconsin, Superior, Wis.
	Minneapolis	*M'polis A.C.*	7:30, 1st, 3rd Wed.	Public Library	Mrs. M. G. Simpson, 3220 Clinton, *Colfax* 4331
	St. Paul	*St. Paul Tel. Club*	7:30, 2nd, 4th Wed.	Macalester Coll.	Mrs. E. Pfremmer, 636 Grand Ave. (5)
MISSOURI	Fayette	*Central Mo. A.A.*	7:30, Last Sat.	Morrison Obs.	R. C. Maag, 611 Bluff St., Fulton
	Kansas City	**A.A. & T.M.s*	8:00, 4th Sat.	Private homes	Reginald Miller, Merriam, Kans.
	St. Louis	†*St. Louis A.A.S.*	8:00, Sat.	Private homes	A. M. Obrecht, 2913 Park Ave.
NEVADA	Reno	***A.S. of Nev.***	8:00, 4th Wed.	Univ. of Nevada	E. W. Harris, University of Nevada
NEW JERSEY	Jersey City	†*Revere Boys Club*	7:15, Mon., Tue.	Gregory Mem. Obs.	Enos F. Jones, 339 Wayne St.
	Teaneck	†*Bergen Co. A.S.*	8:30, 2nd Wed.	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
NEW YORK	Buffalo	†**A.T.M.s & Observers*	7:30, 1st, 3rd Wed.	Mus. of Science	Dr. F. S. Jones, 83 Briarcliffe, Cheektowaga
	New York	**A.A.A.*	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *En.* 2-8500
	New York	†*Junior A.C.*	7:30, 4th Fri.	Amer. Mus. Nat. Hist.	J. Rothschild, Hayden Plan., *En.* 2-8500
	Rochester	*Rochester A.C.*	8:00, Alt. Fri.	Rochester Museum	H. O. Woodard, 485 Hayward Ave. (9)
	Schenectady	†*S'tady A.C.*	8:00, 3rd Mon.	Schenectady Mus.	Miss Betty Douglas, 714 Altamont Ave.
	Utica	†**Utica A.A.S.*	7:30, 4th Tue.	Proctor Inst.	John Zimm, 103 Richardson Ave.
	Wantagh	*Long Island A.S.*	8:00, Sat.	Private homes	A. R. Luechinger, Seaford Ave., 1571
N. CAROLINA	Greensboro	†**Greensboro A.C.*	8:00, 1st Thu.	Woman's Coll., U.N.C.	Mrs. Z. V. Conyers, 210 W. Fisher Ave.
	Winston-Salem	†**Forsyth A.S.*	7:30, Last Fri.	Private homes	Kenneth Shepherd, 1339 W. 4th St.
OHIO	Akron	*A.C. of Akron*	8:00, 2nd Fri.	Beth.-Luth. Church	Mrs. R. J. Couts, 878 Kennebec Ave. (5)
	Cincinnati	**Cin. A.A.*	8:00, 2nd Fri.	Cincinnati Obs.	E. B. Bentley, 2600 Observatory Rd. (8)
	Cincinnati	**Cin. A.S.*	8:00, 3rd Wed.	5556 Raceview Ave.	John Dann, 3318 Felicity Dr. (11)
	Cleveland	†*Cleveland A.S.*	8:00, Fri.	Warner & Swasey Obs.	Mrs. S. K. Towson, Warner & Swasey Obs.
	Columbus	**Columbus A.S.*	8:00, Last Tue.	McMillin Obs.	J. A. Hynek, Ohio State Univ.
	Dayton	*A.T.M.s of Dayton*	3rd Sat. Eve.	Private homes	F. E. Sutter, RR 7, Bx. 253A (9)
	Lorain-Elyria	*Black River A.S.*	8:00, 2nd Mon.	Clearview School	Louis Rick, Box 231, Lorain
	Toledo	*Toledo Ast. Club*	....., 3rd Tue.	Univ. of Toledo Obs.	E. D. Edenburn, 4124 Commonwealth Ave.
	Warren	†*Mahoning Val. A.S.*	8:00, Thu.	Private homes	S. A. Hoynos, 1574 Sheridan, NE, 25034
	Youngstown	**Y'town A.C.*	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 905 Brentwood
OREGON	Portland	†**Portland A.S.*	7:00, 1st Wed.	Central Pub. Lib.	H. J. Carruthers, 427 S. E. 61 Ave.
	Portland	†*A.T.M. & Observers*	8:00, 2nd Tue.	Private homes	N. C. Smale, 831 N. Watts St.
PENNSYLVANIA	Beaver	†**Beaver Co. A.A.A.*	8:00, 4th Tue.	Com'y Bldg., Tamaqui	Mrs. R. T. LuCaric, Box 463, Baden
	Philadelphia	†*A.A. of F.I.*	8:00, 3rd Fri.	Franklin Institute	Edwin F. Bailey, *Rit.* 3050
	Philadelphia	**Rittenhouse A.S.*	8:00, 2nd Fri.	Morgan Physics, U.Pa.	Sarah Lippincott, Sproul Obs., Swarthmore
	Pittsburgh	†**A.A.A. of P'burgh*	8:00, 2nd Fri.	Buhl Planetarium	Charles H. LeRoy, R.D. 11 (15)
RHODE ISLAND	Providence	*Skyscrapers, Inc.*	8:00, Mon. or Wed.	Ladd Observatory	Ladd Obs., Brown U., *Jackson* 1-5680
S. CAROLINA	Columbia	*North'n Cross A.S.*	8:15, Every Mon.	Melton Observatory	Dr. L. V. Robinson, Univ. of S. C.
TENNESSEE	Chattanooga	**Barnard A.S.*	8:00, 3rd Fri.	Jones Observatory	C. T. Jones, 302 James Bldg., 7-1936
	Nashville	**Barnard A.S.*	7:30, 2nd Thu.	Vanderbilt Univ.	Miss J. Saffer, 446 Humphrey St. (10)
TEXAS	Dallas	†*Texas A.S.*	8:00, 4th Mon.	Various auditoriums	E. M. Brewer, 5218 Morningside, *U6*-3894
	Ft. Worth	**Ft. Worth A.S.*	8:00, 4th Fri.	Texas Christian U.	L. C. Eastland, 5501 Byers Ave. (7)
	Houston	*Houston A.S.*	7:30, Last Fri.	Mus. Nat. Hist. Annex	Mrs. J. Murray, 1007 W. Gray (6)
	Port Arthur	†*Port Arthur A.C.*	....., 2nd Tue.	Private homes	G. van den Berg, Box 266, Groves
UTAH	Salt Lake City	***A.S. of Utah***	8:00, 2nd Fri.	City and County Bldg.	Junius J. Hayes, 1148 East 1 S.
VERMONT	Springfield	†*Springfield T.M.'s*	6:00, 1st Sat.	Stellafane	John W. Lovely, 27 Pearl St., 535-W
VIRGINIA	Norfolk	†**A.A.S. of Norfolk*	8:00, 2nd, 4th Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau, 21745
	Richmond	†*Richmond A.S.*	8:00, 1st Tue.	Builders Exchange	Miss L. Sievers, 4018 Clinton Ave. (27)
WASHINGTON	Tacoma	*Tacoma A.A.*	8:00, 1st Mon.	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 N. Union Ave.
	Yakima	†**Yak. Am. Ast'mers*	8:00, 2nd Mon.	Cha. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.
WISCONSIN	Beloit	*Beloit A.T.M.'s Cl.*	....., Alt. Thu.	YMCA Bldg.	Kenneth W. Schultz, 959 Johnson St.
	Madison	†***Madison A.S.***	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	†**Milw. A.S.*	8:00, 2nd Mon.	Public Museum	E. A. Halbach, 2971 S. 52 St., W. Allis



The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of May, respectively.

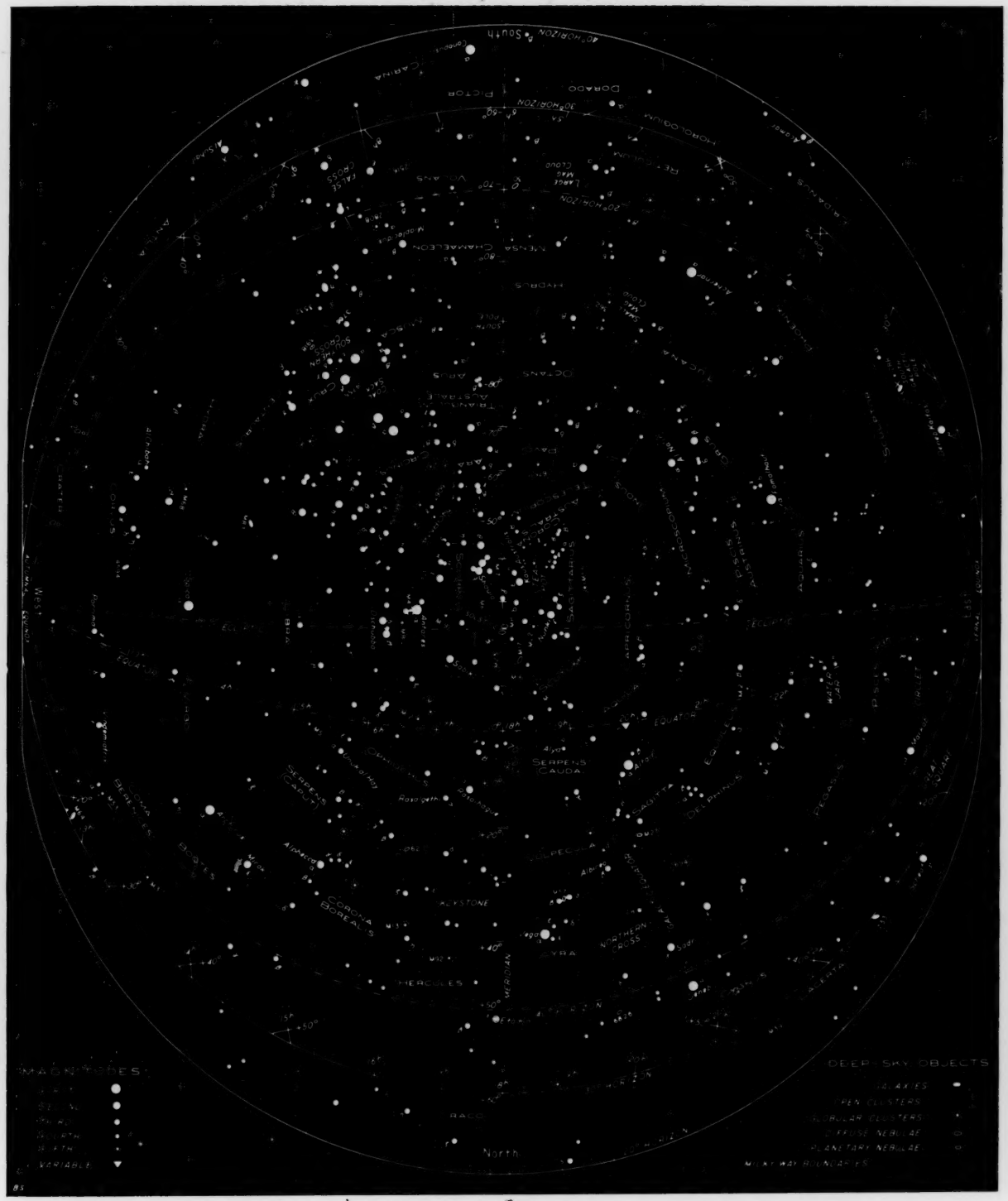
STARS FOR MAY

THE DESIGNATIONS ^{h}, ^{m}, ^{s}, are customarily used for the time units of right ascension (hours, minutes, and seconds), and if there is a decimal point the superscript precedes it or coincides with it. The right ascension of Vega may be expressed as $18^h\ 35^m\ 14^s.66$, or approximately as $18^h\ 35^m.2$.

Catalogues may give the positions of stars in right ascension to thousandths of a second, but for the use of amateur astronomers, positions in **Sky and Telescope** are usually given to tenths of minutes (see, for instance, the list of asteroid positions on page 175).

The other co-ordinate in the equatorial system is **declination,** measured north and south from the celestial equator. Hence it must always be designated plus or north, minus or south, as is latitude on the earth. It is expressed in degrees, minutes, and seconds of arc (°, ′, ″), with the symbols written over or preceding the decimal point. The declination of Vega is +38° 44′ 9″.6, or approximately 38° 44′.

The asteroid positions give declination to the nearest minute of arc. As 360 degrees of arc equal 24 hours of time, a minute of arc is equivalent to only four seconds of time (at the equator); hence, approximately the same accuracy is ex-



The sky as seen from latitudes 20° to 40° south, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of August, respectively.

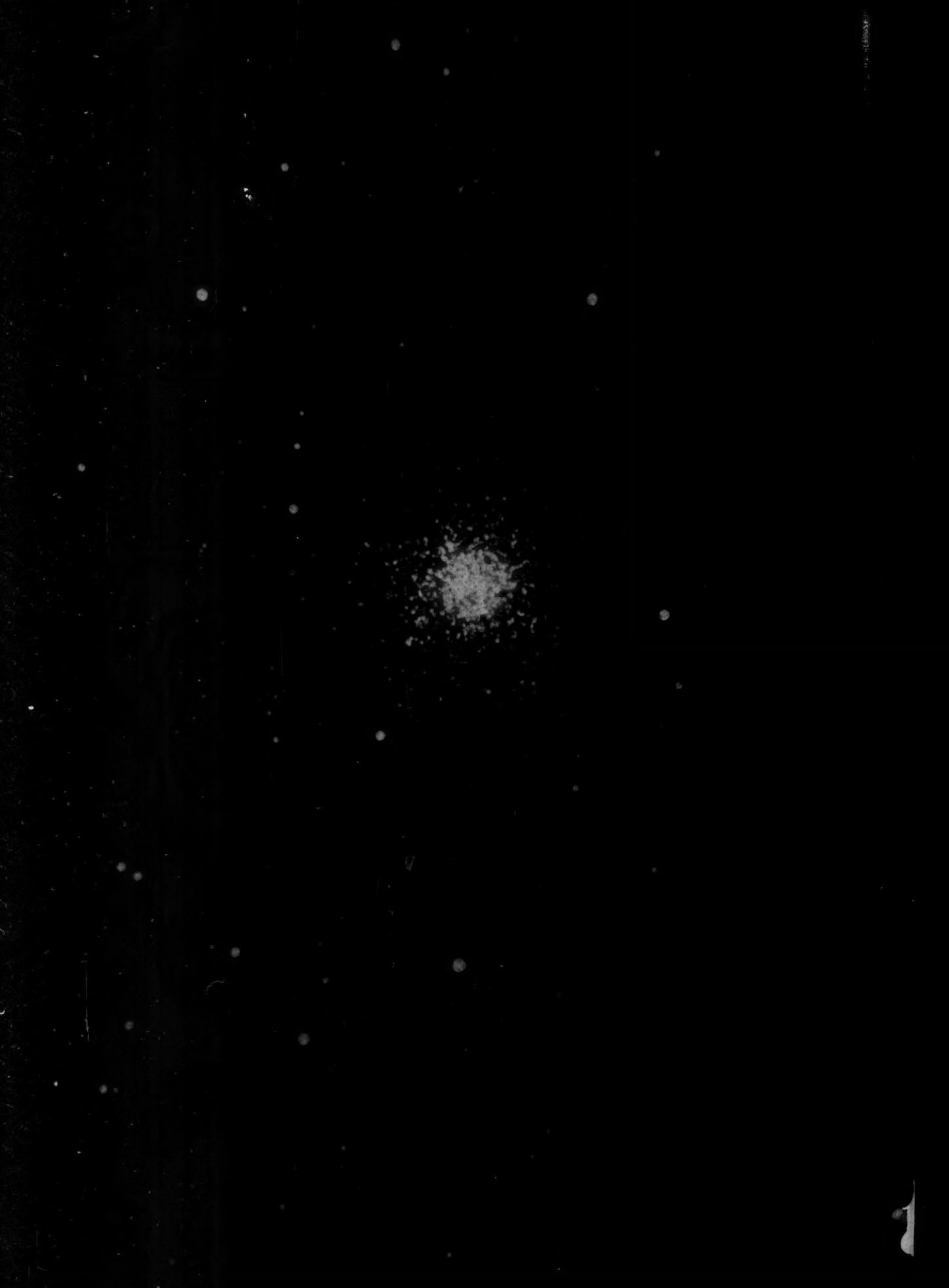
SOUTHERN STARS

pressed by tenths of a minute of time in right ascension and by minutes of arc in declination.

The following table of equivalent values may facilitate comparison of right ascension and declination units in the vicinity of the celestial equator:

$1^h = 15°$	$1^m = 15'$	$1^s = 15''$
$1° = 4^m$	$1' = 4^s$	$1'' = 1/15^s$

From the equator poleward, however, the right ascension circles converge, and it is necessary to apply a correction depending on the average declination of the region involved. The correction is small at first, but becomes rapidly very great near the poles, where the hour circles meet. The factor to apply is the cosine (cos) of the declination. For instance, at 60° north or south declination, the hour circles are only half as far apart as at the equator, for cos 60° = 0.5. At this declination, then, one hour equals only 7°.5.

Hour circles are all great circles, whereas declination circles are all small circles, except the equator, of decreasing size until the poles are reached. But they are equally spaced apart, and no change in the scale of declination takes place in any part of the sky.

Next month we shall note how declination is plotted in this projection.